ARMY ORDNANCE

VOL. XV, No. 90 MAY-JUNE, 1935

Mechanized Forces
John K. Christmas

Churchill's "Marlborough"
Liddell Hart

The End of Disarmament
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The Bow as a Missile Weapon
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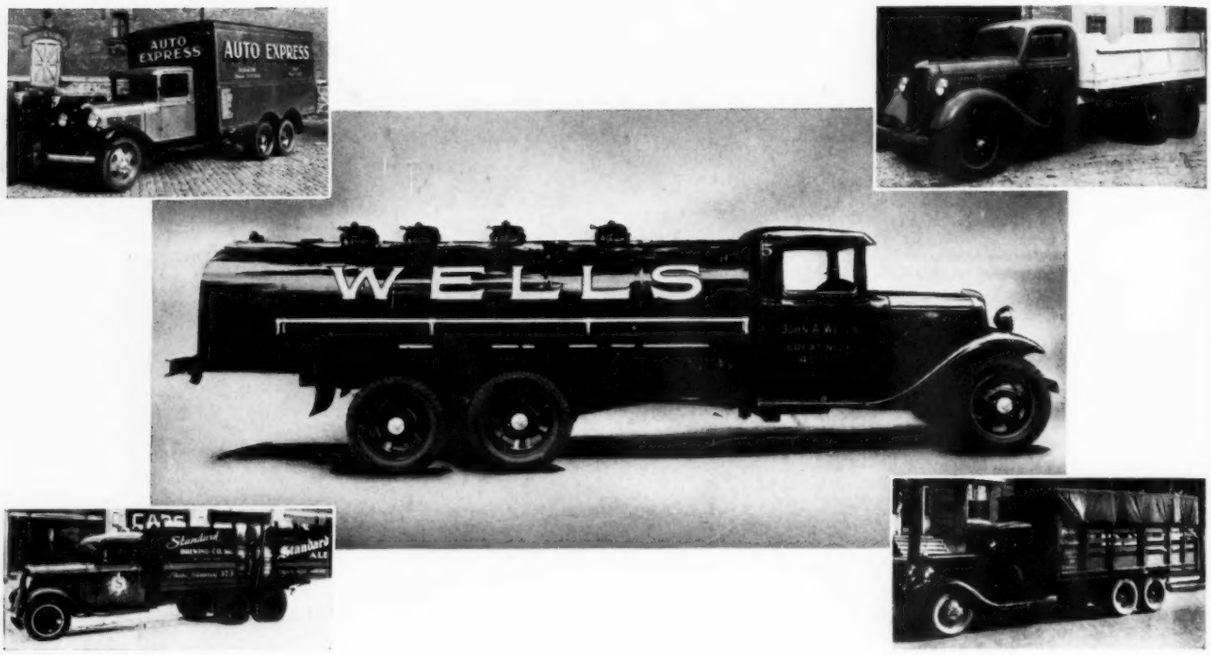
J. D. Pedersen

Carts Before Horses
An Editorial

A BIMONTHLY REVIEW OF AMERICAN MUNITIONS
PUBLISHED BY THE ARMY ORDNANCE ASSOCIATION, WASHINGTON, D. C.

MODERNIZE



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ARMY ORDNANCE

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Now in its Fifteenth Year of Publication

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"I would especially invite you to consider; First, the importance of preparing for war in time of peace by providing proper armament for our seacoast defenses. Proper armament is of vastly more importance than fortifications. The latter can be supplied very speedily for temporary purposes when needed; the former can not."—*President Ulysses S. Grant, Fifth Annual Message to Congress, December 1, 1873.*

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THE Army Ordnance Association is a national organization of American citizens pledged to industrial preparedness for war as our nation's strongest guarantee of peace.

The Association endeavors to keep alive an interest in and knowledge of the design, production and maintenance of munitions. Other than a few manufacturing arsenals—six in all—there is no peace-time industry for the production of ordnance. Should war unhappily come again, industrial America will be called upon to produce munitions in great quantity and of intricate and unusual design. In an emergency time will not permit careful study or long preparation for the production of munitions. The problem is one of vital concern.

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The Association is devoted solely to the national defense; it has no commercial interests, no political alliances, and no religious affiliations. It is not operated for profit: its income is expended in furthering its aims. Its officers and directors serve without remuneration.

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To assist in effecting industrial preparedness for war as being one of the nation's strongest guarantees of peace;

To keep available the highly specialized knowledge necessary for arming the manhood of the nation by stimulating interest in the design and production of ordnance material;

To promote mutual understanding and to effect cooperation with American scientists, inventors, engineers and manufacturers in civil life and the regular and reserve officers of the Ordnance Department;

To provide, when required, the services of competent committees to investigate and report upon special ordnance subjects;

To assist in developing and maintaining an efficient personnel, both commissioned and enlisted, for the units required for Ordnance Field Service in the event of an emergency;

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OF THE

ARMY ORDNANCE ASSOCIATION

Will Be Held on October 2 and 3, 1935

The Business Session, for the discussion of Ordnance progress and the award of The Association's Medal of Merit will be held on the evening of Wednesday, October 2, at Washington, D. C.

The Technical and Scientific Session to witness current tests of military equipment will be held, with the approval of the Secretary of War, during the entire day of Thursday, October 3rd, at the Aberdeen Proving Ground, Maryland.

Admission will be by card to be furnished members in due course.

ARMY ORDNANCE

Volume XV MAY-JUNE, 1935 No. 90

Mechanized Forces

A Study of Supply and Evacuation, I

By John K. Christmas*

THE term "mechanization," broadly speaking and as regards military forces, refers to any use of mechanical means to enhance the combat power and—or the mobility of troops. However, since the introduction of the tank into warfare by the British on the Somme, September 15, 1916, the term "mechanization" has come to refer to the more limited field of multiplying the powers of troops by the use of self-propelled vehicles carrying men, weapons, armor and other fighting equipment in various forms and to varying degrees. The War Department has adopted the following official definition of "mechanization," particularly to distinguish it from "motorization" which refers solely to the substitution of motor for animal draft in the transport and supply echelons and for furnishing strategic mobility for combat troops: "*Mechanization* is the application of mechanics directly to the combat soldier on the battlefield."

Our Army organized its first mechanized force in 1928 at Fort George G. Meade, Maryland, followed by a later and better equipped force at Fort Eustis, Virginia. These forces, of all arms, were in 1930 superseded by a mechanized cavalry regiment at Fort Knox, Kentucky, looking toward the early development of a mechanized reinforced cavalry brigade. At the time when this was done the War Department ordered all arms and services to experiment with and develop mechanization in their own sphere, in the following words: "Every arm is authorized to conduct research and experiment with a view to increasing its own power to perform promptly the missions it has been especially organized and developed to carry out. Every part of the Army will adopt mechanization—and motorization—as far as is practicable and desirable. To the greatest extent possible machines will be used to increase the mobility, security, and striking power of every ground arm, but no separate corps will be established in the vain hope that through a utilization of machines it can absorb the missions, and duplicate the capabilities, of all others." (Annual Report of the Secretary of War, 1931.)

The writer's research in connection with this study and, to a much larger extent for seven years while engaged in the development of mechanized vehicles in the Ordnance Department, indicates that while tactical development has lagged considerably behind technical development, as is necessarily the case, there has been practically no development with respect to the supply and evacuation of mechanized units. However, a considerable amount of information on this subject is available here and there, requiring only integration and evaluation to be of value; this is particularly so if these data are used to reason inductively and comparatively from the principles now established for the logistics of nonmechanized units. Since the World War has well established that logistics have a considerable influence on strategy and tactics it appears highly desirable that a thorough study be made of the logistics of mechanized units in order that (1) a supply system may be developed that is suited to their tactical qualities; (2) an idea may be had of the relative logistics of mechanized and nonmechanized units; and (3) those logistic elements requiring further investigation and tests may be summarized.

There has been very little written on the supply of mechanized units but here and there in tactical treatises occur brief references to supply. Many writers see as the principal drawback to mechanization what they call the enormous quantities of gasoline and ammunition such a unit must have compared to a similar nonmechanized unit. Believing that some of these statements are not based on accurate analyses this study very carefully examines this aspect of the subject.

THIS study is based on the Reinforced Cavalry Brigade (Mechanized) as outlined in Table 50, "Reference Data," Command and General Staff School, 1933. Photographs of typical vehicles furnished by the Ordnance Department are shown herewith. The organization given there was supplemented by the use of detailed tables for the component and reinforcing units. [Note: A "combat car" is a fast track-laying fighting vehicle, similar to a tank, used by mechanized cavalry.] The brigade consists of the following units: brigade headquarters, Cavalry regiment (mechanized, see Table I), 75-mm. artillery battalion (mechanized), Engineer troop (motorized), chemical troop (motorized), and Ordnance company (light maintenance).

The Cavalry brigade (mechanized) has been chosen for this study because (1) it is the unit now being developed in our Army; (2) a cavalry unit, due to its missions away from the supply bases, is the most difficult to supply; and (3) this unit is used in instruction at service schools.

There being nothing *absolute* about the matter of supplying tactical units in the field, the only yardstick with which to measure the supply factors of a new unit is an old, established unit of comparable tactical value. The cavalry division has been selected for this purpose, with certain modifications noted below. It will be remembered that the cavalry division contains the following combat units: 4 cavalry regiments; 1 75-mm. regiment, horse artillery; 1 squadron, armored cars (36 cars); 1 light tank company (slow, truck-transported tanks), and 1 squadron engineers.

The following changes were made in the cavalry division in order to get a more accurate comparison between the two units: Medical squadron detached, as the cavalry brigade (mechanized) has no medical unit as part of its organization.

*Captain, Ordnance Department, U. S. Army.

Add the following weapons: 36 machine guns, cal. .50 (in armored car squadron); 36 sub-machine guns (in armored car squadron), and 288 machine guns, cal. .30 (36 in armored cars; 192 to replace machine rifles in cavalry regiments).

Increase the "day of fire" for small arms ammunition, *due to addition of above weapons,* from 45 tons to 62.3 tons.

Since certain aspects of this study require a comparison of the supply of a mechanized and of a nonmechanized unit, it is important that a fair degree of tactical equality be established between the two units used. The tactical value of a mechanized unit being a questionable matter requiring years of research, development, maneuvers and even some actual combat to determine, the only fairly reliable yardstick at this time is considered to be *the relative fire power of the two units;* this is the same general rule used at the Command and General Staff School for comparing the tactical (or combat) strength of the infantry division and the cavalry division. It is realized in applying this rule that each type of unit, mechanized and horsed, has certain advantages over the other and that these qualities are to a large extent both intangible and open to argument. However, it is believed that the normal "day of fire" is a fair index to the fire power of a unit and therefore it may be said that the cavalry brigade (mechanized) and the cavalry division (horsed) are approximately equal, their days of fire being:

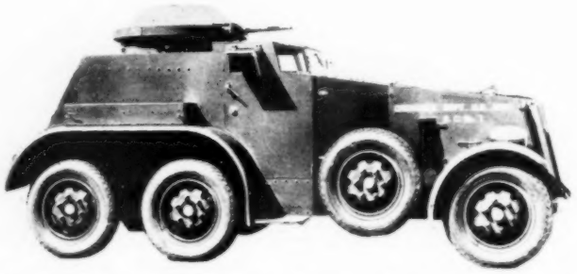
	Mechanized Brigade	Cavalry Division
Small arms	92.8 tons	62.3 tons*
Artillery (75mm)	47.5 "	95.0 "
Total	140.3 tons	157.3 tons

*Corrected for additional machine guns—See above.

The organization and equipment of the two units, as regards men, animals, weapons, and vehicles is summarized in Table II.

OUR Field Service Regulations (Washington, U. S. Government Printing Office, 1923), paragraph 583, say in part "The administration of the supply system is based on the fundamental principle that the combat troops should not have their attention diverted from the task of defeating the enemy by anxiety concerning supply and replacements. The impetus in the movement of supplies and replacements should be given *by the rear* which so organizes its services that the normal routine requirements are replaced automatically and without the preliminary of requisitions."

The German Field Service Regulations, 1921, in par. 795, discussing the various echelons of supply state "Only when supplying large cavalry units, operating in advance of the army front, are rearward (corps and army-*author*) supply columns



THIS ARMORED CAR, WITH ITS CREW, IS SELF-CONTAINED FOR A 2-DAY MISSION AWAY FROM ITS SUPPLY BASE.

brought forward to distributing points." (A distributing point is defined in the same paragraph as the point where division trains deliver to field trains of combat troops.)

Further, paragraphs 977 to 980 describe their system of gasoline and oil supply to motorized units by special gasoline and oil motor columns, under army responsibility and control, to division distributing points; further, that the gasoline and oil are handled in barrels. (Except that special tank trucks called "mobile tank stations" supply *separate* motor vehicles of headquarters and troop units.)

The French Field Service Regulations in paragraph 251 say in part: "In any situation it is important: to push forward as closely as possible to the troop units to be supplied the matériel and subsistence supplies which must be delivered to them, in order to reduce to the minimum the task of their own agencies of transportation."

Based on these principles, our general logistic system (as well as that of the British, French and Germans) is for the higher echelons (usually the army) to be responsible for delivering supplies to combat units at railheads (usually for

TABLE I

CAVALRY REGIMENT
(Mechanized)
Abbreviated Table of Organization

Units	Strength	Vehicles	Weapons (a)		Remarks
			.30	.50	
Headquarters	37	.....	.....	.....	
Headquarters Troop	138	58	16	1	
Covering Squadron	183	57	58	25	(Consists of sq. hq., armored car trp. and scout trp. 18 arm. cars and 7 combat cars).
Combat Car Squadron (each)	153	45	56	27	(There are 3 sqdrns. like this in the regt.) (27 combat cars per sqdrn.) (c).
Machine-gun Troop	142	34	25	.....	(22 personnel carriers for M. G. crews.)
Regiment	978	287(b)	267	107	

Notes: (a) Machine guns only listed; for complete list of weapons see Table IV.
(b) This figure does not include the regiment's proportion of the 2-ton cargo trucks (80) added to the brigade to carry the supplies recommended in this study.
(c) Also six 1.85-inch semiautomatic guns per squadron.

TABLE II

LOGISTIC DATA FOR THE CAVALRY BRIDGADE (MECHANIZED) AND THE CAVALRY DIVISION

Item of Logistics	Mechanized Brigade.	Cavalry Division	Division Excess	Ratio: Horse/Mech.
War strength (Off. and Enl. men)	2346	9275	6929	3.95
Rations (tons)	5.87	23.19	17.32	
Animals	0	10714	10714	
Grain rations (tons)	0	53.57	53.57	
Hay (tons)	0	75.00	75.00	
Vehicles (total, all kinds)	771	910	139	1.18
Wagons and other horsed vehicles (75mm guns not included)	0	482	482	
Trucks, cars, motorcycles, etc.	481	356	—125	0.74
Combat motor vehicles	290	60(a)	—230	0.21
Gasoline for one day (tons)	71.99(b)	14.40(b)	—57.59	0.20
Oil	3.60	0.72		
Total, gasoline and oil (tons)	75.59	15.12	—60.47	0.20
One day of Cl. I supplies (tons)	81.46	166.88	85.42	2.02
Same, less hay (tons)	81.46	91.88	10.42	1.13
Trucks (2-ton) to haul 1 da. Cl. I	41	84	43	2.05
Same, without hay	41	46	5	1.12
Class I supplies, lbs/man/day	69.5	36.0	—33.5	0.52
Mobility factor: mi./ton Cl. I	1.84(c)	0.15(c)		0.08
Same, without hay	1.84	0.27		0.15
Road space: Troops	12.0	16.5	4.5	1.37
(miles) Trains	2.2 d)	2.7	0.5	1.23
Troops and trains	14.2	19.2	5.0	1.35
March radius on supplies carried (miles)	450	100	—350	0.22
Weapons (Types and No. of each):				
75-mm. guns	12	24		
1.85-inch semiautomatic guns	36	0		
37-mm. guns (one-pounder)	0	22		
4.2-inch chemical mortars	8	0		
Cal. .50 machine guns	215	36(e)		
Cal. .30 machine guns	556	360		
Sub-machine guns cal. .45	298	36(e)		
Rifles, machine	0	6		
Rifles	722	5054		
Pistols	2646	8512		
Day of fire (tons):				
Small arms (incl. chemical)	92.8	62.3	—30.5	0.67
Artillery	47.5	95.0	47.5	2.00
All classes	140.3	157.3	17.0	1.12
Losses (Attack in meeting engagement) (f)				
Men: dead	3	12	9	4.0
to evacuation hospital	38	149	111	
evacuation: ambul. loads	7	25	18	3.6
Animals: dead		54	54	
to evacuation hospital		172	172	
Combat motors (g) (estimated)	29	6	—23	0.21
Replacements required:				
Men	41	161	120	3.9
Animals		226	226	
Combat motors	29	6	—23	0.21
R. R. cars required for all replacements	17	21	4	1.24
Class II-III-IV supplies (less ammunition), 1 day supply (in tons) (h)	11.8	46.5	34.7	3.94
Total, 1 day of all supplies:				
In tons	334	371	37	1.11
In 5-ton trucks (i)	67	75	8	1.12
In railroad cars	12	13	1	1.08
Railroad trains for a movement (k)	14	57	43	4.07
Ship gross-tons for a movement	25000	135000	110000	5.4
Overseas supply (less ammunition) (l) (tons) (daily)	40	158	118	3.95
Fire power per man per day (Based on the day of fire); (in lbs. per man):				
Small arms only	79.2	13.5	65.7	0.17
All classes	119.5	34.0	85.5	0.29

(a) 24 of these are light tanks transported on trucks on the march.
(b) One day's march for mech. brig: 150 mi; for cav. div: 25 mi.
(c) The "mobility factor", proposed in this study as a measure of efficiency in mobility, is similar to the measure "miles per gallon" for a motor car.
(d) Includes 80 2-ton trucks added to mechanized brigade to carry the extra supplies proposed in this study.
(e) These are in the 36 armored cars in the armored car squadron.
(f) Table 45, Reference Data, C. & G. S. S. used.
(g) Losses in combat motors *estimated at 10%* in an attack in a meeting engagement, reasoning from World War data on tank losses in attacks on positions and zones.
(h) Table 30, Reference Data, C. & G. S. S., figures for detached corps used as none for lower units available.
(i) This is predicated on 5-ton trucks because the army would probably use such trucks in its supply convoys to the advanced refilling point.
(k) Standard 33-car railroad trains.
(l) Table 31 (division), Reference Data, C. & G. S. S. used.

General Notes—

Slide rule in computations.

Data for the cavalry division (less medical squadron) are from Reference Data, except that figures have been adjusted for lack of med. sqdrn; also, figures for days of fire of small arms have been adjusted for the increased number of machine guns now in the cavalry division.

Some of the explanatory notes and general notes are enlarged upon in the text of the study.

The "Fire Power per Man per Day" given in last item is based on the "day of fire" and is not considered quite as accurate for tactical purposes as that based on the maximum sustained rate of fire of the weapons; the latter method is discussed in an article by the author in *Army Ordnance*, Vol. XI, No. 61, July-August 1930, page 22.

Class I supplies only) and depots, located on a railroad usually, if possible, just out of all enemy artillery fire and within a *reasonable round trip* by motor of the field trains of the combat units. When combat units are marching this general rule depends on the condition existing in our present cavalry and infantry divisions that the division service trains (being motorized) have a rate of march from two to four times that of the combat troops. This means that the troops can be one, two or even three days' march from the railhead and still be supplied by the service trains (and by those field and combat trains which are motorized). Please note this as it has an important bearing on the supply of a mechanized (or any wholly motorized unit) on the march away from its base.

WHEN we come to the wholly mechanized unit, which is of course also wholly motorized, the condition discussed above no longer exists; the service and other trains have little or no advantage (and in some cases, such as with armored cars, the trains are at a disadvantage) in actual marching speed over the combat troops. It is at once apparent that in this case the combat troops cannot be supplied daily by their integral or organic trains at a distance over one-half day's march from the railhead (or other army distributing point or depot) unless the trains contain *empty transportation* equal to one day of supply and of fire.

It will be of interest to note here what Lieut. Col. G. J. Fiebeger in his "Elements of Strategy" says under "Communications," (page 16): "The Count de Paris in his 'History of the Civil War' deduces the conclusion that an American army of 100,000 men equipped with 4,000 ordinary army wagons, utilizing three or four common country roads, cannot be subsisted in a barren country at a distance exceeding twenty-five to thirty miles from some point on a railway or navigable river. *For a greater distance the ratio of the number of wagons to the number of miles is a rapidly increasing one.*" This passage is of interest because it shows what can be expected in units having no motors; here, because the trains are only a little faster than the troops, the distance from railhead can only be between one and two days' march; and even here the trains must have operated on a loop when the troops were at maximum distance from the railhead. Using a Civil War unit, our present divisions and a mechanized unit we can construct the following approximate table: (Trains marching 8 hours on round trip to railhead.)

Unit	Rate of March		Ratio of Rates of March	Daily March (Troops)	Max. Dist. from Rhd.
	Troops	Trains (which run to Rhd.)			
Civil War. Div...	2½ mi./hr.	3½ mi./hr.	1.4	12 mi.	14 miles
Inf. Div.....	2½ "	14 "	5.6	12 "	56 "
Cav. Div.....	5 "	14 "	2.8	25 "	56 "
Mech. Brig.....	20 "	20 "	1.0	150 "	80 "

We can see from this table that, with unit trains holding one day of supply, in order that the unit to be supplied be more than one day's march from the railhead the trains must march faster than the troops and when the trains march at the *same speed* as the troops (i.e., in mechanized units) these can only be supplied at a distance from the railhead of one-half day's march. Any performance above this distance must come from (1) excessive organic trains so that one day of supply may be going to the troops while an empty train is going to the railhead; or (2) excess transportation (from railhead) furnished by a higher echelon. An accepted principle being that the higher echelon should get supplies to the combat troops, the second method is considered much the better.

For example, when marching let the unit leave the railhead area (A) (let us say at daylight) and march 150 miles (maximum daily march of mechanized brigade) to a new bivouac (B) leaving behind at the railhead empty trucks for one day of supply. These trucks, when loaded from the incoming daily train, march after the unit to its new bivouac (B). Here they may transfer their loads or take the place in the unit of the trucks now empty (due to a day's consumption having taken place), the latter to remain in the bivouac (B) when the unit again marches. When the railhead is opened at B that night, the trucks left behind are loaded and march after the unit to the latest bivouac area (C), etc.; and this presumes that the railheads can be advanced behind the mechanized unit at the rate of 150 miles per day, which is quite unlikely. It is considered that the reader will admit that there will be many cases where a railhead cannot be placed within one day's march of the brigade. Further, that due to the high speed of the brigade, it will seldom have missions lasting more than a few days away from its railhead. It would therefore appear best to adopt these principles for the brigade trains: (1) Do not include any empty trucks; (2) carry in the brigade trains enough supplies to last several days; and (3) if a larger march away from the base is required either (a) attach additional truck companies to the brigade, or (b) supply an advanced refilling point for the brigade by motor convoys under control of a higher echelon (say, the army).

Since any train, in addition to that necessary to carry reasonable unit reserves, is uneconomical and a serious tactical disadvantage to a cavalry or highly mobile unit, it would appear that this conclusion may be drawn: For wholly motorized units (such as the reinforced mechanized brigade or division) the army (or other higher unit responsible for supply) must be responsible for supply and evacuation to within one-half day's march of the field trains (or of the combat trains if the unit have field trains and no service trains).

This does not necessarily apply if the brigade is going on a raid or other mission lasting only a few days, as the brigade can then live on its unit reserves.

That such supply convoys will be needed has been considered in Great Britain. Maj. Gen. J. F. C. Fuller, in "Lectures on F. S. R. III," says in his discussion of the supply of a mechanized force: "In armies largely dependent for their mobility on petrol it is obvious that the protection of convoys will become all-important, and that, consequently, special mobile line of communications protective units will have to form part of the field army" (page 47).

Captain Boileau, British Army, in his "Gold Medal Essay, 1930," proposes a system of endless chain motor convoys operating between the railhead and the B echelon (service trains of the mechanized unit). The writer agrees wholly with this but considers that these convoys should be under army control and *not attached* to the mechanized brigade.

The mechanized brigade has a maximum daily march of 150 miles, which is six times that of the cavalry division and ten times that of the infantry division. Therefore, when the mechanized brigade is employed with nonmechanized units it is considered most unlikely that it will have tactical, or even strategic, missions more than a day's march (150 miles) from the larger and slower force; the distance will probably be considerably less. It would therefore seem desirable to provide the mechanized brigade with supplies sufficient for a round

trip of 300 miles plus one day in reserve (or a total of three days), with respect to fuel. Regarding rations something more should be provided as they are *always* consumed to the maximum while fuel consumption will be reduced if there be delay, halts, or combat. Contrariwise, ammunition consumption varies considerably with the situation and, except for antiaircraft weapons, is not ordinarily used daily on marches, so that a lesser number of days of five than of rations may be carried.

On the subjects just discussed Captain Boileau says in regard to the distance supplies must be carried (page 6): "Apart from the long distance raid, which may be scheduled separately, it does not seem probable that these would often exceed 160 miles at most." (Page 10) "British armoured brigades carry one day of ammunition in "A" echelon and one and one-half days in "B" echelon. ("A" echelon is with the troops, "B" echelon the brigade trains.) (Page 13) "Principle of petrol supply is that there must always be a necessary refill readily available."

The desirability of carrying as much ammunition as possible in the forward echelons of the brigade, ahead of the railhead, in order to increase the tactical power of the weapons is shown

CROSS-COUNTRY MACHINE GUN CARRIER.

by this quotation from a book, "Modern Military Administration" by Maj. Gen. J. C. Harding-Newman, the Director General of Transportation, British Expeditionary Force, 1918: "The lesson here is that the more echelons of mobile ammunition there are in front of railhead, the greater the power of the gun. The railways and railheads are not the limiting factors. These are to be found in the echelons in front of railhead." (Page 63.)

Having briefly reviewed the logistic principles involved we shall now apply them specifically to the mechanized cavalry brigade, reinforced, in order to see from actual detailed computations how much of a practical problem the supply of the brigade is. It is possible that the quantities of supply involved will be such that we must deviate from the general principles as well as from the accepted practice in nonmechanized units as to amounts carried and where carried.

THE supply of rations (an element of Class I supplies) is a rather small matter in the brigade because we have a unit equipped with 771 motor vehicles requiring only 5.87 tons of rations per day. The mobility of the vehicles allows them to be used over a wide area in one day which lays them open to wide separation from each other, and they will often be employed singly or in small groups, hence it is believed *the vehicle to which a man is assigned* rather than the troop should be the *first echelon* in rationing. (Every man in the brigade rides on a motor vehicle.) Therefore, instead of prescribing that one reserve ration (carried on the man) and one ration on the troop kitchen be carried, it is recommended that one reserve ration be carried on the man (as before) plus two field rations "B" be carried on the vehicle for each man normally carried on that vehicle, or a total of three rations available *to any man anywhere* on detachment from his troop or similar unit. This would, for example, allow a section of armored cars to make a 300-mile (2-day) round trip away from its troop with an "iron" ration in reserve in case of delay or breakdown. No particular or specially difficult arrangements need be made for the carrying of these rations, except in the case of the combat cars. In these, due to the limited room in the crew compartment it will probably be necessary to carry the rations in a special box on the outside of the car. The additional weight, per vehicle, is of course negligible. (Crew 3 men; 2 day's rations, 30 lbs.) Neglecting the "iron" ration, which is not usually considered, the brigade still needs one ration to be provided with three as is the cavalry division.

Whenever possible, the troops are of course to mess by troop or similar units; therefore, the troop kitchens (or combat trains) must carry at least one ration. Again the possibility of detached service and wide separation looms up, so that the troop should be able to subsist separately or detached as long as possible. It is therefore recommended that the combat train carry two field rations (A or B, depending on the situation); for the combat car troop at war strength this only amounts to 740 lbs., and can be carried on the kitchen truck. In a larger unit, such as the machine gun troop, one ration could be carried on a truck of the combat train.

While the brigade now has three rations as prescribed for the cavalry division, and one extra, it is further recommended that one ration be carried in the regimental (field) train; in the case of the cavalry regiment (mech.), this ration will amount to 4890 lbs., requiring 1 and ¼ two-ton trucks.

SUMMARY OF RATIONS TO BE CARRIED

Where Carried	Type	No.	Weight
On man	"Iron"	1	
On vehicle	B	2	5 lbs. x number men on vehicle
On kitchens (combat train)	A or B	2	11.64 tons
On field train	A	1	5.87 tons
Total		5	(not counting emergency or "iron" ration)

This will allow the brigade to be away from its base 5 days (discounting the iron ration) or 3 days if the same rule be applied as in other organizations, viz.: that there must never be less than two days' rations with the troops.

The idea presented here of carrying as much Class I supply (and also ammunition, as will be discussed later) in the foremost echelon (the vehicle) is of course only possible in a wholly motorized unit. Aside from the argument, in case of combat vehicles particularly, that the vehicles may have to operate widely separated is the opportunity thus afforded to reduce appreciably the size of the trains required and—or increase the supplies carried. Two days' rations for the crew of four men, or 40 lbs., is negligible on an armored car weighing 8000 or 9000 pounds, but these rations lumped for the brigade in a service train aggregate 11.64 tons, requiring six 2-ton trucks. (*To be concluded in next issue of this Journal.*)

Churchill's "Marlborough"

Some Running Reflections on the Finer Points of Generalship

By Liddell Hart*

'THAT first volume[1] was certainly a fine piece of advocacy—but was it quite history? Churchill has certainly exposed the maliciousness of some of the blackest reflections on Marlborough's character, but one still has an uneasy feeling that there was more ground for suspicion than the biographer would desire to leave us. He is a bit too obviously counsel for the defense—methought he did protest too much.

'Now for the second volume—for this is what most of us have been waiting for: Marlborough as a general, painted by a man who can appreciate the finer points of generalship. This chapter on the structure of the War promises well—it is so clearly put. And these sketch-maps are the most graphic aid to the reader I've come across—what a good idea. It's interesting to learn that Marlborough was a pioneer in developing fire-power—but where is the evidence for it. Churchill really ought to give some; the question is so important, not least because of its effect on the claims made for Frederick. Hullo, now he quotes a phrase to prove the French failure to appreciate it, but he is surely putting too much stress on the phrase.

'Ah! this is good—the comparison between the instantaneous appreciation of factors and adjustment of action required of an old-time general, and the comparative leisureliness and simplicity of a modern general's decisions. How few people appreciate this. Novelists are apt to imagine a general's conference as being like an elaborate scientific experiment in a laboratory. Churchill knows better, and he has done a service to truth in exposing this delusion. But I wonder if he doesn't rather overpaint the functioning of military genius in the past—it is so easy to ascribe to the processes of the subconscious what may have been no more than a lucky accident.

'IT'S interesting to be told that it was through Marlborough that we broke the Tory tradition of strategy—that of using the army as a limb of seapower—and threw our weight into Continental Warfare. This makes Marlborough the forerunner of the "Westerners"—of Haig, Robertson, and Henry Wilson—but I wonder how these would have felt if they had realized that they were heirs of the Whigs and fighting directly contrary to Tory principles!

'According to this book, Marlborough aimed at a decisive battle from the time he arrived in the theater of war. But it doesn't give satisfying evidence of the fact. And this habit of saying Marlborough "intended" or "without doubt he meant" becomes rather trying. I must look up the Marlborough despatches. . . . I've done so—what a lot to go through—and it seems to me that Churchill is reading more into them than they mean, and reading them with a late 19th century cast of thought. It is clear that Marlborough wasn't averse to battle—if he got a favorable chance—but he seems much more inclined to appreciate the results of maneuver and siege to gain strategic points than Churchill allows. That, after all, was natural to his time. And what about that curious action in sending an apology to the French that it was not his fault that he had not joined battle—was it, perhaps, more subtle than it appears?

'The next chapter—and the 19th century outlook again: Churchill is exaggerating the general unwillingness of 18th century generals for battle, by failing to recognize the technical difficulties that hampered them. Has he not ever studied Colin's exposure of this fallacy?

'Here's certainly a new light on Marlborough himself—evidence of "Marlborough's vehement and fierce behavior behind the scenes." The unruffled calm which other biographers have portrayed was almost inhuman—it didn't seem to fit other sides of his character. And here's another point—the fact that he was getting £60,000 a year in pay and allowances makes it difficult, especially in view of his fondness of money, to brush lightly aside those accusations that he had an interest in prolonging the war. At any rate, when one weighs also his obvious soldierly fondness for the war game, it makes Churchill's portrayal of him as essentially a high-souled patriot seem a trifle unnatural.

'BUT this is a good point—however keen on winning a decisive victory in his own theater, Marlborough showed remarkable breadth of view in seeing the value of success in the Mediterranean and Italy. And what a contrast to our own "Westerners" in his readiness to spare some of his best troops for the distraction.

'Now here is evidence that, in 1703, he was eager for battle. Perhaps too eager. Even Churchill seems to think that the Dutch had more reason on their side than Marlborough, when he pressed for a frontal attack upon the "Lines," near Antwerp, held by a numerically superior enemy. As in the case of Jellicoe, who could lose the war in half an hour by courting a battle which chanced to end in defeat, there was something to be said for the Dutch theory of "an army in being." Are Churchill's jibes at their "victorious without slaughter" ideal quite fair? Marlborough seems to have had a touch of Haig in his apparent tendency, when frustrated, towards gambling against the odds. Was he courting a smaller but more irreparable Passchendaele?

'The impression grows when one comes to the Danube campaign of 1704. The brilliancy of the move and of its execution are superbly shown—those successive sketch-maps showing the "scarlet caterpillar" are an inspired touch. And Churchill is justified in pointing out its resemblance to the Dardanelles design of 1915, as well as its greater risk. It was a move that marked an artist of war, and must have given

*Author: Foch, The Man of Orleans; The Real War, 1914-1918; Sherman, The Genius of the Civil War; The Decisive Wars of History; Reputations; The Remaking of Modern Armies; Scipio Africanus—A Greater than Napoleon; Great Captains Unveiled; Paris, or the Future of War; The Science of Infantry Tactics. Military correspondent and adviser on defense, *The London Times*. Lees-Knowles lecturer at Trinity College, Cambridge, 1922-23; Leverhulme Research Fellow. Captain, British Army, Retired.

1Marlborough: His Life and Times, by Winston Churchill. New York: Chas. Scribner's Sons. 1934.

Editor's Note: To avoid confusion in the author's references it should be noted that Vol. I as published in England appeared as Vols. I and II in the United States. Vol. II of the British edition, covering Marlborough's campaigns, with which this article deals, is published in the United States as Vols. III and IV.

as much artistic delight in the execution as now in the description. The only flaw on this is the rhetorical flourish—"Not Wolfe before Quebec, not Nelson before Trafalgar, nursed a purer love of his country's cause than Marlborough in this supreme passage in his career." To dwell upon it as a "burden," and as if he had less compensation than, and equal risk of life as, the humble soldiers is shoddy thinking. There are too many "funeral oration" touches in this biography, and too little clear recognition of the motives of human nature.

'But the march itself is a masterpiece of description. Like Sherman's, its perfect organization without a large "G" and "Q" staff offers a suggestive reflection on modern ideas of necessity. Another fresh point is Churchill's correction of the customary idea that Marlborough and the Margrave of Baden commanded on alternate days—but, stay, surely Hare's account, which was "perused by Marlborough," speaks quite definitely of "His Grace's turn to *command*"?

'What strikes me as a far more important point is why, in the move against Donauworth, he allowed time for the enemy to reinforce it with 14,000 men. Yet Churchill seems to miss the point. The map shows that barely five miles were covered on the crucial July 1st. Marlborough certainly made great haste on the 2nd, and seems to have been wise in not delaying the assault till the 3rd. But was he justified in assaulting at all?

'To those who judge by results—as do most military critics even—his success may be answer enough. It cost him dearly, but on this score alone one would not judge it adversely. It looks, however, as if he had more luck than Churchill admits in escaping a costly failure. Was he gambling too high? His very distrust of his ally suggests this—for he could hardly have relied on his ally intervening in the nick of time.

'Then after the fortunate victory he seems to have had no clear idea of what to do—as even Churchill makes clear. He's now becoming a more penetrating critic: he shows that Marlborough, contrary to what many apologists have said, was mainly responsible for the devastation of Bavaria. But I wonder if Churchill, with his battle-theme, here credits this economic pressure with too little chance of success!

'SO far as one can see there was no touch of genius, or even of tactical skill, in the plan of battle at Blenheim. And whatever one may allow for Marlborough's "tact" in regulating his current of force there, it was several times a toss-up that he was not beaten. Such gambling isn't evidence of the highest quality of generalship. Even Churchill speaks of Marlborough's "moods of awful gambling," although he says they "sprang from cold calculation." I can't see at Blenheim any sign of the astute calculation which marked Cromwell's plan at Dunbar. It was, clearly, the British rank and file who turned the balance at Blenheim, and luck seems to have done more than Marlborough to ease their overweighted task.

'The next year's campaign showed the persistent gambling instinct again. His plan of advance up the Moselle, with the Margrave converging, was a sound one. But as Churchill points out—his criticism is growing surer—Marlborough persisted in it when every condition of success had miscarried. There's the Passchendaele flavor again here. But at least he didn't risk an attack when blocked, and eventually fell back. The fiasco was less harmful than a disaster. Perhaps he had learnt something from his touch-and-go victory at Blenheim: if so, it is highly significant, for only a rare man learns from success. He was less uncommon, however, in the way he hastens to shift all blame onto his ally's shoulders—even sending such a message to his opponent, Villars!

'BACK in Flanders. There's some clever generalship in the plan of piercing the Lines of Brabant, but the attempt at deception is not accompanied by any positive distraction. And he seems to have paid forfeit for deceiving his allies even more thoroughly than the enemy—as in Maude's move on Baghdad, such secrecy may ultimately prove expensive of opportunity. What is more he seems, as Churchill admits, himself to have "flagged" when opportunity was at its height. If he was as pleased over the fragmentary result as his letters suggest, he was also prone, like many lesser generals, to self-deception. And here's another touch of Passchendaele in the way that the mud on the route taken by the cavalry contributed to the fiasco of Marlborough's next move.

'Ah! this is better. The story of "The Unfought Waterloo" is an addition to history and to understanding of Marlborough's military quality. If his final effort of the 1705 campaign brought no better success, it revealed a better Marlborough. There's a subtle calculation in the plan. Instead of repeating narrow maneuvers that the enemy can foil, he tries an indirect approach by a route that offers alternative objectives. Thus, this time, he has the enemy "completely mystified" and leads them to disperse their forces in order to cover the several places at which he may strike. Then he suddenly swings north to Waterloo, and the enemy hastily prepares to move to the rescue of Brussels when, sidestepping, he appears on their distracted front—it would shortly have been their marching flank. Did he show his hand a shade too soon?

'All this makes me wonder whether Churchill and some previous biographers have overlooked the time factor. Certainly, they don't emphasize it, but rather seem to treat Marlborough's military career as static rather than evolving in skill. It would be more natural to find him learning his craft by experience, and reflection on his lessons. Isn't that what the facts convey, in analysis?'

. . . . . .

HERE I have written down the successive reflections that passed through my mind as I read Mr. Churchill's "Marlborough." It may have more value than a conventional review as a study of an evolving impression.

Moreover, the highest compliment one can pay the book is to devote one's space to critical comment upon some of its less obvious aspects. For to one who has travelled much in the realm of military history, which is mostly a drab expanse with limited views, to come upon a book by Mr. Churchill is like a sight of the Hill of Cassel rising out of the Flanders Plain. One can always hope for a good view from the top, at least if the atmosphere be clear.

Apart from his literary powers, Mr. Churchill has two exceptional qualifications for writing a life of Marlborough. He has personal experience of the way that human affairs are conducted, an experience which the academic historian often too palpably lacks. He has a knowledge of war—a knowledge of its technique in which the civilian historian is deficient, and an insight into its depths as well as into its relation to policy which the strictly military historian rarely attains; here, I would remark that I have long since come to think that the best practical composition of our command on the Western Front would have been Churchill as Commander-in-Chief with a trained staff officer as his Chief of Staff.

The Bow as a Missile Weapon

A Study of Power, Range and Rapidity of Fire

By Vice Admiral W. L. Rodgers*

IN a study of the history of the development of naval tactics which has occupied me for several years I was struck by the fact that after the invention of gunpowder it was several centuries before the hand gun replaced the bow as the missile weapon of infantry, ashore and afloat. Gunpowder was first used as the driving power for military projectiles about the year 1326. Possibly King Edward III of England used some kind of cannon on board ship at the great naval battle of Sluys, in 1340, when he secured the mastery of the English Channel which facilitated his conquest of France a few years later. Certainly he used cannon at the decisive battle of Crecy in 1346. Thereafter cannon began to gain over heavy mechanical artillery, but the gun as a portable weapon in the hand of the individual soldier did not begin to gain on the bow until the early part of the 16th century, when a portable firearm was developed which, in the course of time, slowly replaced archery. At the great battle of Lepanto in 1571 the 25,000 soldiers in the Turkish fleet were almost all archers. Two centuries later, at the opening of our Revolutionary War, in the difficulty of finding ammunition for the American army, so able a man as Benjamin Franklin thought that on account of its great rapidity of fire and effective range of 200 yards, archery would be sufficiently serviceable against the flintlocks of the British army. In his well known Memoirs General Marbot says that at the battle of Leipzig in 1813 a French cavalry corps was charged by thousands of Russian archers who had no other arms. Their arrows filled the air but did little damage. Nevertheless, Marbot himself was wounded by an arrow and one of his men near him was shot completely through the body and died in a few minutes. Sir Ralph Payne-Gallwey, a modern authority on archery and mechanical artillery, thought that at ranges under 150 yards the British longbow of the 16th century was a more effective weapon than the "Brown Bess" musket with which the British army was armed until 1840. The short Turkish composite bow of horn, sinew and wood was even better than the longbow.

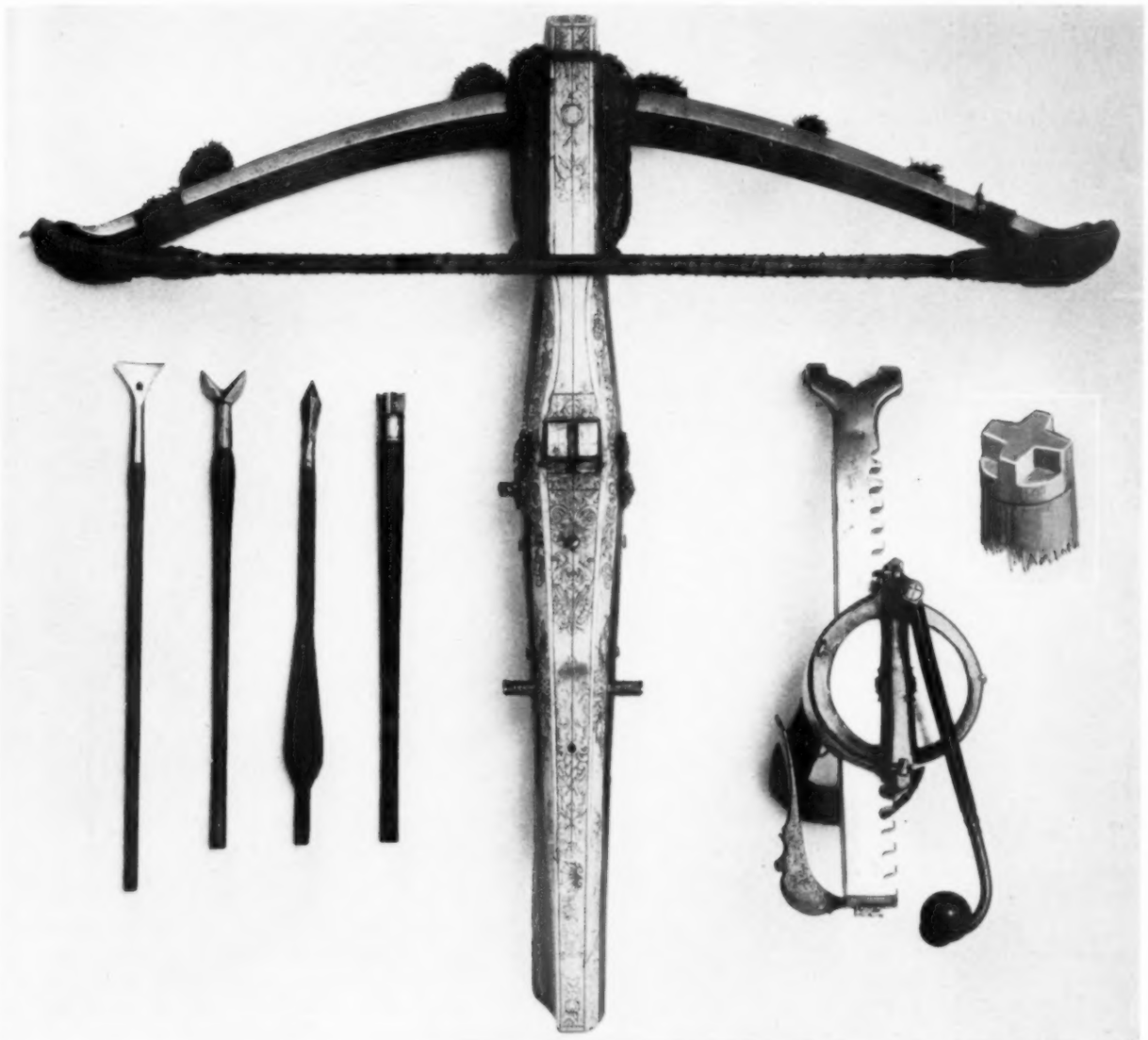
These little-known facts in the history of warfare caused me to examine and compare the power range and rapidity of fire of the bow in its various types with the capabilities of early missiles thrown by gunpowder.

AS we all know, the bow is a very old weapon, originating in the stone age and was and is of the simplest form, being merely a piece of elastic wood bent into an arc by the bowstring. Power to drive the arrow was obtained for many centuries by the strength of the archer's two arms. The power of the bow was limited by and varied with the individual strength of the archer, but the rapidity of discharge was considerable—as high as six aimed shots a minute. Soon after 1000 A. D. a stronger bow came into general use which was known as the crossbow. In this form the bow itself was mounted on a wooden stock forming a cross. When drawn, the bowstring was held in tension by a sear and trigger. The power to draw this heavy bow was derived from the muscles of the archer's back. He placed the center of the bow on the ground and standing upon it with both feet, he took the string in both hands and straightened his back to cock the string. He then drew a missile (bolt or quarrel) from his belt or quiver and placed it in a shallow directional groove running the length of the stock. The sear holding the bowstring had a slot in it which allowed the bolt to rest against the string while the latter was at the "ready." After pointing the weapon as we do a small arm, it was discharged by pulling the trigger. Naturally the increased power of the crossbow was accompanied by a slower rate of discharge, from one minute to one and a-half minutes, depending on the type of winch used to draw the string. Gradually, the strength of the crossbow increased; the wooden bow was replaced by a composite one of wood, horn and sinew and, finally, before 1500 A. D., by heavy spring steel. At the same time the power devices for drawing the bowstring became complicated and heavy. But always in these five centuries there was a field for the light, quick-firing longbow and the slow-firing, powerful but heavy crossbow. (See Fig. 1, next page.)

While the longbow was effective against the mass of infantry wearing only a stout leather "jack" coat for protection, the crossbow bolt with less initial velocity and range was a much heavier projectile than the arrow and with greater striking energy, so it was effective against leaders and gentlemen wearing chain mail. Like all new weapons, it offended conservative opinion and, in 1139, Pope Innocent II put it under interdict, but without result. It was the superior striking force of the crossbow which caused the development of plate armor and this again brought about stronger crossbows, until at length the armored knight could scarcely move when dismounted. Probably gunpowder had little influence on the growth of heavy body armor, for the strongest man could not carry armor which would turn the smallest cannon shot and hand guns amounted to little until after the days of the heaviest body armor. (Of course the crossbow may be as light as desirable and small ones were used very recently and still may be used in some parts of Europe for small bird shooting, as they make no noise.)

A great disadvantage of the crossbow was its weight. A heavy bow of a late type weighed 20 pounds or more. The mill for winding it up added several pounds, and the projectiles were heavy so that the whole came to 25 or even 30 pounds; whereas a longbow with a quiver and sheaf of 24 arrows was perhaps 5 pounds. On the other hand, by the use of the winch to wind the crossbow, the little man was able to shoot as strongly as the big man, and for ship service the weight of the crossbow was of comparatively little importance. So we find in the accounts of naval battles in the Mediterranean in the 12th and 13th centuries much mention

*President, Naval War College 1911-13; member General Board of the Navy 1915-16; Commander-in-Chief Asiatic Fleet, 1918-19; member General Board and chairman, executive committee 1920-24; member Advisory Council, Conference on Limitation of Armament, Washington, 1921; technical adviser, Commission of Jurists on Laws of War, The Hague, 1923. Vice-Admiral U. S. Navy, Ret.



Courtesy of the Metropolitan Museum of Art

FIG. 1. HEAVY STEEL CROSSBOW OF THE 16TH CENTURY.

On the left are shown crossbow bolts or quarrels. The first two of these (from left to right) are cutting tools suitable for firing against ships' rigging; the next is a flight bolt for long range; the last is a heavy armor-piercing quarrel with flat four-pronged head. The lengths of the bolts shown are from 13 to 16-inches; the weights from 1.5 to 5 ounces. On the right is the mill for winding the crossbow; its power: 400 to 1. The inset shows the crossbow bolt head.

is made of crossbowmen, who were very highly esteemed in Italy, France and Spain. Genoese crossbowmen were particularly highly rated and were hired by other countries. The English longbow does not seem to have been an early national weapon. The Northmen were famous bowmen and Norman William owed them much at the battle of Hastings. Two centuries later King Edward I of England, in his Welsh wars, learned to value the Welsh archers and, after his conquest of Wales, he developed them to high efficiency in his own armies and the bow was recognized as the distinctive English weapon. King Edward III's great naval victory at Sluys was largely owing to his archers who shook the French resistance from a distance before the ships closed to let the men-at-arms board and complete the matter with pike and sword. But even so, the longbow was never able entirely to supplant the crossbow, and English Kings constantly employed crossbowmen, even when the reputation of the longbow was at its highest. At the naval battle of Lepanto, in 1571, the Turks had 25,000 archers against as many Christian arquebusmen. The Turkish commander-in-chief personally used a Turkish bow, for skill with which he was famous, while the Venetian commander-in-chief handled a crossbow having an attendant to wind it up.

FROM old bows in existence it seems that a longbow was 6 feet or more in length and shot an arrow a clothyard (37 inches) long. When strung and at rest the bow at its center was about seven inches from the string and the length of the draw was 28-29 inches. The strain or pull on the bowstring necessary to draw the arrow to its head was technically known as the "weight" of the bow and was 60 pounds or even 90 pounds for a war bow. The range of the arrow varied with its own weight and the "weight" of the bow. Besides it was affected by skill in the release of the string. From the best information that has come to us, English military target

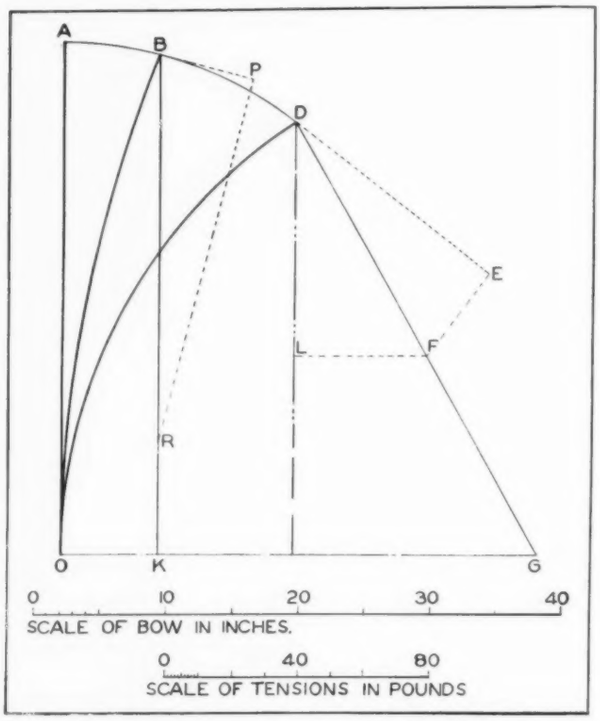


Fig. 2. Diagram Showing Amount of Work Accumulated in Drawing a Long Bow.

practice in the 15th and 16th centuries was common at ranges up to 200 yards, and the ordinary war arrow could range as far as 250-300 yards, according to the strength and skill of the individual archer. About a quarter or one-third of each man's supply for war were "flight arrows" which were lighter than the others and could attain a range greater by 50-60 yards, but they had less striking force at all ranges. The term "bowshot" was a popular expression for 400 yards and we may believe that the longbow was not capable of exceeding this range unless in the hands of a champion of a county or when favored by a strong wind. The aid of the wind was important in war. At the battle of Towton during the English Wars of the Roses, in a snow-storm which made for poor visibility, the Yorkists shot down-wind and found the Lancastrians within range. They stepped back a few yards and continued to fire. The enemy replied, unaware that their return fire to windward was falling short, and they lost the battle.

In spite of the wonderful tales of the marksmanship of Robin Hood, William Tell and other mythical heroes, the percentage of hits at archery was small at any range greater than a few yards. We may be sure of this, for the records of target practice in recent years preserved by the Archery Associations of Great Britain show that the highest winning score in a long series of annual shooting matches was 72 per cent of hits on a four-foot circular target at 100 yards distance. The same champion won in another year with a score of 45 per cent. The lowest winning annual score was 20 per cent. We may therefore believe that one hit out of four on a target of a standing man's silhouette at a measured range of 100 yards would be most remarkable practice. Firing at a man at an unmeasured range of about the same distance in war conditions, four or five per cent of hits would be a very high score. Of course, in battle the target would be several lines of men behind each other instead of at single persons, but even so, it is not probable that the full sheaf of 24 arrows averaged as much as one enemy casualty.

We may calculate the ballistics of a bow. Fig. 2 is a diagram showing half a bow such as that recovered from the "Mary Rose" sunk by the French fleet in 1545 and now in the Tower of London. OA is the unbent bow, from center O to tip A. OB is the strung bow at rest. BK is the string, OD is the fully drawn bow with the string DG. The assumed "weight" of the bow is 80 pounds. Draw LF parallel to OG to represent 40 pounds, the "weight" of this half of the bow. Then DF is the strain on the bowstring. The curve ABD represents the path of the tip of the bow as it is extended. At D draw a tangent to ABD. From F drop a perpendicular on this tangent to the point E. Then DE is the strain on the bow itself necessary to draw the arrow to its head. In accordance with the rule for springs the strain on the bow when the tip is drawn to any point on the line ABD is proportional to the distance the tip is drawn from A. The mean strain in drawing the arrow while the tip of the bow passes from AB to D is $\frac{AB + AD}{2\ AD} \times DE$. The distance drawn is AD — AB. So $\frac{AB + AD}{2\ AD} \times (AD - AB) \times DE =$ work done in inch pounds. To get the work in foot-pounds for both sides we divide the above by 6 and have 96.5 foot-pounds as the whole work of drawing the arrow to its head. But in releasing the bowstring not all the energy is taken up by the arrow. Part is absorbed in giving motion to the bowstring and another part by the bow itself. A light bowstring allows a higher velocity to the system, but is more liable to breakage. A heavy arrow takes up a higher percentage of the accumulated energy in the bow than a light one, but has less initial velocity on which the range primarily depends.

Through Mr. N. C. Wiley, the Bureau of Construction, Navy Department, was good enough to supply me with data as to the strength of small flax cordage. It appears that a cord 27/64 of an inch in circumference will run 188 feet per pound and have a breaking strain of 352-380 pounds. This gives a weight per square inch per fathom of 2.25 pounds and a tensile strength per square inch of 24.850-26.830 pounds. Referring to the diagram the strain on the bowstring is equal to the line DF or 80 pounds. But when the bow is at rest the strain on the string will be even greater. Drawing a tangent at B whose length is OP, equal to $DE \times \frac{AB}{AD}$ we have the strain on the bow at rest. A perpendicular from P to R on the line BK gives the strain BR 106 pounds, on the string when it is at rest. Taking a factor of safety of 4 and the breaking strain as 25.000 pounds per square inch, the weight of the bowstring per fathom should be 0.3816 pounds. For the actual length of 74 inches it would be 0.0392 pounds. Let us assume the weight of an ashen war arrow with iron head as nine to the pound or 778 grains (the flight arrow, slenderer and with less feather area, might be 500 grains). We have 96.5 foot-pounds available in the drawn bow. Let us first arbitrarily set aside 3 foot-pounds as waste, leaving 93.5 foot-pounds to be distributed in work on the bow, on the string and on the arrow. Let the velocity of the arrow be V foot-seconds. Then the energy it takes up will be $\frac{V^2 \times 0.111}{64.4}$ foot-pounds. At its middle point the velocity of the string will be the same; at its ends it will be less. From the diagram it may readily be calculated that the

mean velocity of the string is 71.5 per cent of the velocity of the arrow. Consequently, the work it absorbs will be $\frac{(0.715V)^2 \times 0.0392}{64.4} = \frac{0.0200V^2}{64.4}$ foot-pounds. Turning now to the bow of the "Mary Rose," at its center it is 1.5 inches wide by 1.25 inches deep. From the published dimensions of the "Mary Rose" bow it appears that it is of nearly the same proportion as a Swiss bow in the Metropolitan Museum, which weighs 1 lb. 6½ ozs. So that we may take the weight of the "Mary Rose" bow as 1.34 pounds. Referring again to the diagram and taking account of the cross section of the bow at intermediate points; while the arrow moves 28.5 inches from G to K the tip of the bow moves 11.375 inches from D to B. The rest of the bow moves more slowly and its mean velocity (corresponding to the velocity of the radius of gyration of a rigid bow) is to that of the tip as 3.97 inches is to 11.375 inches. The work absorbed by the bow will then be $1.34 \frac{(3.97\ V)^2}{(28.5)} \frac{1}{64.4}$ or $0.0260 \times \frac{V^2}{64.4}$

Equating the sum of these three terms to the whole work accumulated in the bow we have $0.1571 \times \frac{V^2}{64.4} = 93.5$ or $V = 195.7$ foot-seconds. The energy in the arrow will be 66.1 foot-pounds.

Taking the flight arrow of 500 grains, its energy will be $\frac{1}{14} \times \frac{V^2}{64.4}$. The other terms will be the same and equating the sum of the three as before to 93.5 we have 226.5 foot-seconds as the velocity of the flight arrow and its energy will be 56.9 foot-pounds.

The Turkish bow was built of horn and wood backed by sinew. One in the possession of Sir Ralph Payne-Gallwey is described by him as being 45 inches long along its curve with a span when strung of 35 inches with a draw of 17.5 inches and a pull ("weight") of 118 pounds. It thus had about the same energy as the longbow, but, as its weight was small (only 12½ ounces) and its string was short, the percentage of waste energy was much less than in the longbow and it gave a higher velocity and increased range.

The crossbow is of a very different type. It is short and heavy with a small draw and a very much heavier "weight," so that the string must be very heavy and thus much less of the energy is picked up by the "bolt." Fig. 3 shows the half of a powerful steel bow at the Metropolitan Museum at New York, which the Curator of Arms and Armor, Mr. S. V. Grancsay, measured for me. This bow, at rest and unstrung, has a span of 33.87 inches and the versine of its arc is 4.2 inches. From this free position the draw to the sear was 5.5 inches. The metal of the spring was 2.594 inches wide and 0.81 inch deep at the center, and tapering to the ends. The weight of the metal was about 15.5 pounds, with the center of gravity of each arm about 7.6 inches from the center of the bow. The "weight" to draw the bow was 1640 pounds. Referring to Fig. 3, it will be seen that the strain on the bowstring is 3150 pounds. In order to have as little stretch as possible in the bowstring, it was made up of small twine wound in a skein of the proper length and diameter and then "served" with the same small twine to make a "selvagee," as the Navy terms it. This method had the advantage of making the necessary eye at each end of the bowstring for taking the "nock" of the bow. As it was impossible for a man to bend the bow by hand to string it, a "bastard" string was stretched and fastened to the ends of the bow by screw clamps. The

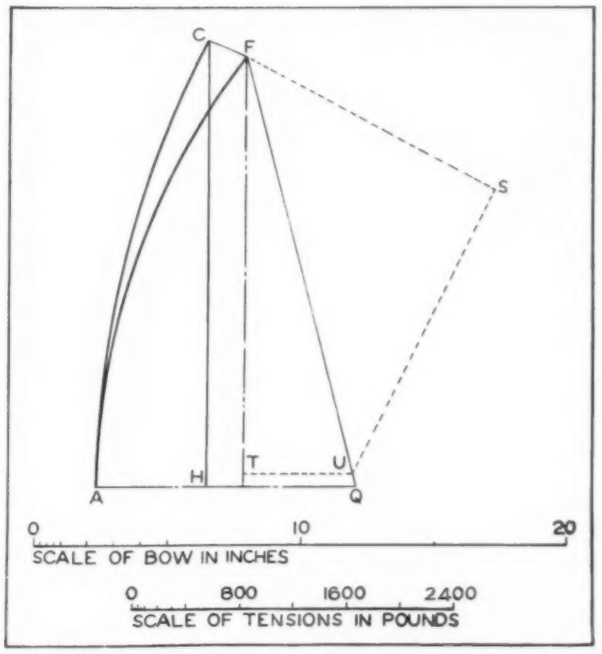


FIG. 3. DIAGRAM SHOWING AMOUNT OF WORK ACCUMULATED IN DRAWING A STEEL CROSSBOW.

bow was then bent by the winch until the true string could be placed and the winch was eased off to remove the bastard. With a factor of safety of 4 and a breaking strain of 12,600 pounds, the diameter of the string would be 0.8 inch. Allowing 34 inches for the length of the bowstring, to have enough to go round the head of the bow, its weight would be 0.535 pounds. The "service" of twine 1/16th inch in diameter would add 0.156 pounds, making the weight of the string 0.691 pound. From the diagram, the work accumulated in drawing the bow from C to F is 263 ft.-lbs. Going through the same process as for the longbow, assuming a heavy bolt to be 5 ounces and a flight bolt to be 1.5 ounces (both such are in the Museum), allowing 2 per cent for waste, the work in the bolt is $\frac{5}{16} \cdot \frac{V^2}{64.4} + \frac{0.691(0.598V)^2}{64.4} + \frac{15.5(0.076V)^2}{64.4} = .258$ and the velocity of the bolt is 160.0 foot-seconds. The energy in the bolt is 124 foot-pounds or nearly double that of the arrow of the longbow, but the range much less. For the flight bolt of 1½ ounces; the terms for the string and bow remaining as before, the velocity becomes 196 foot-seconds and the energy is 56.0 foot-pounds.

IT is not so difficult to calculate the flight of these low-velocity missiles as it is those of the present day, for until the velocity of the missile approaches that of sound the resistance varies simply as the square of the velocity. At my request the late Rear Admiral Moffett, Chief of the Bureau of Aviation, was good enough to ascertain the resistance of an arrow in the wind-tunnel. At a velocity of 200 foot-seconds, the resistance of a 26-inch arrow of 5/16-inch diameter was found to be 0.039 pound. The feathers were three, 2½ inches long, with a total area on both sides of 7.5 inches. Removing them, the resistance at 200 foot-seconds was reduced to 0.016 pound. The formula for the resistance of the feathered arrow was $R = .000000975\ V^2$; and of the bare arrow, $R = .0000004\ V^2$. We may compare this resistance with that for present-day ogival-headed projectiles and get a formula which will enable

us to calculate by small parts the trajectories of arrow forms (or we may calculate them by the ordinary ballistic tables for low velocities). Mayevski's formula for resistance R of ogival-headed projectiles of about 3 calibers in length is $R = \frac{Ad^2V^2}{g}$ where d is diameter of projectile in inches, V is velocity in feet per second and g is gravity = 32.2 feet per second. A is a coefficient whose logarithm is 5.66989 — 10. For abnormally-shaped heads, such as many crossbow bolts had, we must introduce a coefficient B. I assume that the arrow or crossbow bolt resistance will be that of the head as above, plus frictional resistance along the sides, plus feather resistance. For the arrow tried in the tunnel, the body resistance at 200 foot-seconds is R = .016 and the feather resistance = .023 for 7.5 square inches. By Mayevski's formula the head resistance is .00567. This leaves .01033 as the frictional resistance for a side area of 24.55 square inches, or .00042 pound per square inch at 200 foot-seconds. Then for any given arrow whose diameter is d and length (less 3d) is L and feather area (on both sides of the feather) is F, the total resistance is $B\ \frac{(Ad^2V^2)}{g} + \frac{.000421}{40000} \times \pi LdV^2 + \frac{F(.023)\ V^2}{7.5 \times 40000} =$ $(B \times .000001452\ d^2 + .000000033\ Ld + .00000007667F)V^2$ (1)

To derive a formula for the retardation let us suppose the missile to move horizontally on a frictionless table. Let S be the distance run between two speeds, V_1 and V_{11}. Let m be the mass of the missile and R its resistance. We know that $R = K\ V^2$ where K is a constant.

Then $K\ V^2\ dS = -m\ V\ dV$ and $dS = -\frac{m}{K} \times \frac{dV}{V}$ (2)

Integrating we have $\int_{V_{11}}^{V_1} dS = S = \frac{m}{K} \log \frac{V_1}{V_{11}}$ (3)

For a weight of 1 pound, $m = \frac{1}{32.2}$ and for a resistance of 0.1 pound at 200 f.s., $0.1 = 40000\ K$ Or $K = .000\ 0025$

Then $\frac{m}{K} = 12422.3$ and $S = 12422.3 \log \frac{V_1}{V_{11}}$ (4)

Converting to ordinary logarithms, we have

$$S = 28603 \log \frac{V_1}{V_{11}} \quad (5)$$

To get the time of flight we substitute $VdT = dS$ in Equation (2) and integrating we have in seconds,

$$T = 12422 \left(\frac{1}{V_{11}} - \frac{1}{V_1}\right) \quad (6)$$

For other weights and other resistances, the numeral coefficient in equations (5) and (6) will vary directly as the weight and inversely as the resistance of the projectile. The resistance may be found from equation (1), and using it as a percentage of Mayevski's coefficient, the trajectory may be worked out by Ingall's Ballistic Tables, or else, the trajectory may be divided into small parts and each calculated separately in succession by equations (5) and (6) above, making allowance for the effect of gravity on each part.

By the latter method, taking a war arrow of nine to the pound, with a length of 37 inches, diameter 0.35 inch, and feather area of 6 square inches and an ogival head, from equation (1) we have (taking B as unity)

$$S = 7705 \log \frac{V_1}{V_{11}} \quad (7)$$

and

$$T = 3346 \left(\frac{1}{V_{11}} - \frac{1}{V_1}\right) \quad (8)$$

With an initial velocity of 195.7 foot-seconds and an angle of elevation of 42° to attain maximum range, we have a range of 886 feet, with an apex 226 feet high, an angle of fall of 47 1/2°, a remaining velocity of 154 foot seconds and a time of flight of 7.47 seconds.

The flight arrow of 14 to the pound with diameter of 5/16 of an inch, length of 37 inches and only 4 square inches of feather area has a formula of

$$S = 6232 \log \frac{V_1}{V_{11}} \quad \text{and} \quad T = 2707 \left(\frac{1}{V_{11}} - \frac{1}{V_1}\right)$$

With an angle of elevation of 42°, and I.V. of 226 foot-seconds, this gives S = 1068 feet; T = 8.37 seconds; R.V. = 160 f.s. and angle of fall = 50°1/2. The apex is 283 feet high.

The smaller and lighter Turkish bow with its greater stiffness would have an I.V. of 248 foot-seconds, a range of 1250 feet. With only 3 inches of feathers its range might be 100 feet greater.

Turning now to the range and striking energy of the crossbow, the crossbow bolts in the Metropolitan Museum show a great variety of types, particularly in the shape of the heads and it is apparent that the principal object of the crossbow in its later development was to pierce armor. There are some bolts designed for long range, but the shape of heads of many is meant to bite on an inclined surface of steel and such bolts offer so much resistance to the air that their retardation was very considerable in spite of low velocity as compared with the arrow of the longbow. Taking the dimensions of an armor-piercing crossbow bolt at the Metropolitan Museum, it weighs 5 ounces, is 14 inches long, 1 inch in diameter at the head, tapering to the rear. The steel head is flat with its edges standing higher than the center and nicked to make four biting prongs. The resistance of such a head cannot be less than that of a flat surface or about 10 times that of an ogival head. Adding to this the frictional resistance of the body of the bolt for 7.5 square inches of feathers, we shall have a formula of

$$S = 1843 \log \frac{V}{V_{11}} \quad \text{and} \quad T = 800 \left(\frac{1}{V_{11}} - \frac{1}{V_1}\right)$$

for an initial velocity of 156 f.s., this gives a range of only 420 feet for an elevation of 42°., time of flight, 5.4 seconds; remaining velocity, 93 feet; and angle of fall 55° 1/2.

Taking a flight bolt weighing 1.5 ounces, 18 inches long, 0.577 inches in diameter and with pointed head, the formula becomes

$$S = 5710 \log \frac{V_1}{V_{11}} \qquad T = 2480 \left(\frac{1}{V_{11}} - \frac{1}{V_1}\right)$$

With an elevation of 42° and an I.V. of 191 foot-seconds the range will be 820 feet; time of flight, 7.0 seconds; R.V., 137 foot-seconds; and angle of fall 48°.

WHILE the crossbow for personal use came in late mediaeval times, the heavy mechanical throwers were much older, dating back to the time of Alexander and earlier, and the crossbow was an adaptation of the larger weapon.

The classic ballistas threw bolts and also stones up to a talent (57 pounds) in weight to a range of 400 yards (Heerwesen;—Kromayer and Veith). Their motive power came from twisted ropes. Hair and sinew made good materials for the rope on account of their elasticity. Small engines, with 2-foot arms and 4-inch rope could throw a one-pound ball 300-350 yards, and the Romans could throw 6 to 8-lb. balls to a range of 450-500 yards. (Fig. 4.) Payne-Gallwey says that feathered javelins of five or six pounds weight could be thrown 450-500 yards. The arrangement of the device was an upright frame carrying two pairs of vertical ropes which

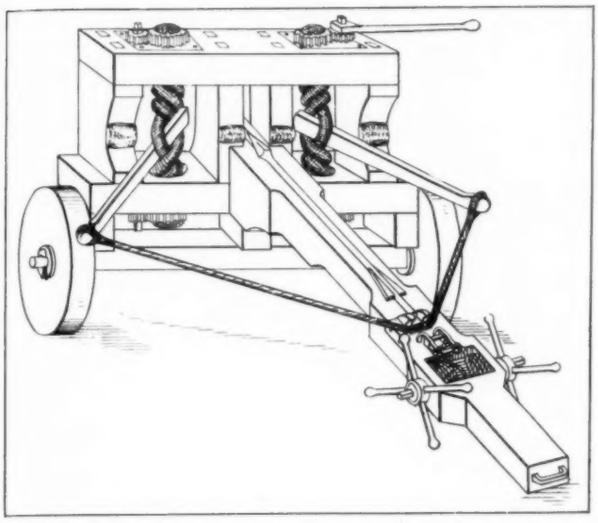


FIG. 4. RECONSTRUCTION OF AN ANCIENT BALLISTA.

This sketch is redrawn, with several changes, from Sir Ralph Payne-Gallwey's work on mechanical missile weapons.

served as springs. A wooden arm was thrust between each pair of ropes and two arms connected at their other ends by a bowstring. When the ropes were twisted a tension was placed on the bowstring. A stock like that of the crossbow was laid in the frame to carry the missile, either bolt or ball, and the string was drawn by a winch, as in the crossbow. Range for 8-lb. shot about 450-500 yards.

Another form of these heavy weapons is shown in two different types in the Castle of St. Angelo at Rome (Figs. 5 and 6). Both are great crossbows mounted on wheeled carriages, which carry winches for drawing the bow to the "ready" position. One machine is a stone ball thrower and the other a javelin thrower.

I regret I did not make precise measurements of these weapons, but a careful study of the photograph shows the springs were approximately 18 feet long, 3½ inches wide, with 4 to 6 laminae of from one-half inch to one inch in thickness. Using the well-known formulas for the stresses and deflections of railway springs to which these bows are similar, and taking the New York crossbow as a standard, we can readily calculate that the weight of metal in these springs, when fully stressed, ought to yield over 6,900 foot-pounds of energy.

The formulas are as follows:

Let n be the number of equal laminae, b their breadth, h their thickness, and l the half length of the thickness and bow; all in inches.

Let P be the compressive force at the tip of one end in pounds and D be the deflection in inches and W the whole work done in the spring in foot-pounds.

Making the constants in the formulas correspond to the trials of the New York spring, we have,

$$P = 20930\,\frac{nbh^2}{l} \qquad D = \frac{Pl^3}{4978000\ nbh^3} \qquad W = 7.34\ nbhl$$

As the laminae in the Roman crossbows are unequal, we consider the thick one first. It is one inch thick. When stressed as much as the New York bow we have P = 646 lbs. D = 49 inches W = 2775 foot-lbs. The other three laminae, one-half as thick, each develops one-quarter as much P and W for the same D, as the stress also is one-half. The total P is therefore 1131 lbs. and the total W 4856 foot-lbs.

Plotting a diagram similar to Fig. 2, it will be found that the draw of the bowstring will be 109 inches. The photograph shows that the draw of the bowstring was about 72 inches and the diagram tells us that W in this case will be only 32 per cent of the full strength of the bow, or 1586 foot-pounds.

The tension on the bowstring will be 689 pounds. Using a factor of safety of 4, the cross section of the string would be 0.110 sq. inch. Its radius would be 0.187 inch and after serving with 1/16 inch twine, its cross section would be 0.196 sq. inch, weighing 1.292 lbs. for a length of 211 inches. From the diagram we find that the mean movement of the bowstring is 50.9 inches and that of the bow is 6.67 inches for a movement of 72 inches by the bolt. The bow weighs about 410 pounds.

Hence we get the equation for the velocity of a five-pound javelin bolt

$$1586 = \frac{5 + 1.292\ (0.707)^2 + 410\ (.0788)^2}{64.4}$$

and V = 112 feet. Energy of bolt 968 foot-pounds. Range about 125 yards.

AS the last of the mechanical throwers we may mention the trebuchet (Fig. 7). This was a siege weapon of great

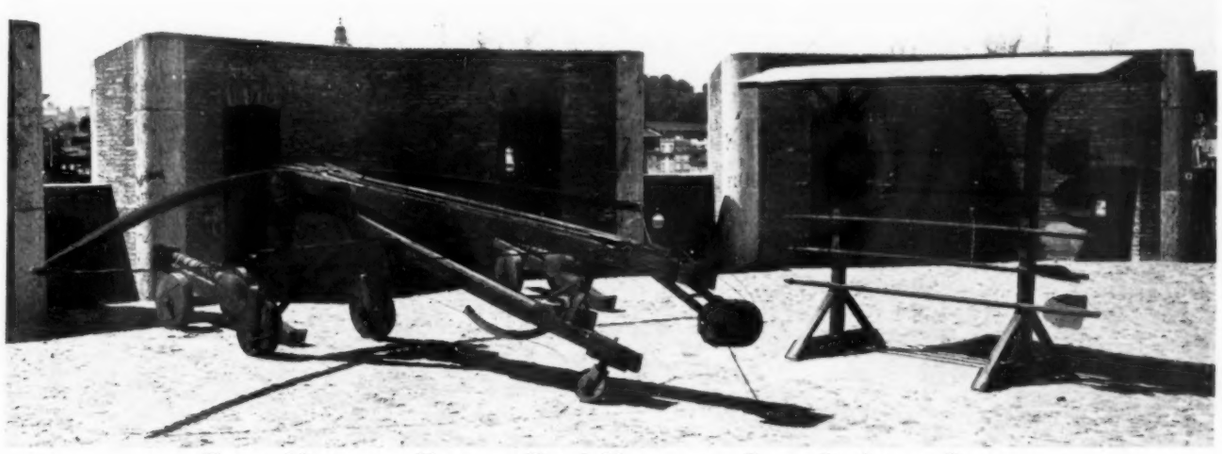


FIG. 5. MECHANICAL THROWER (BOLT) MOUNTED ON CASTLE ST. ANGELO, ROME.

On the right is a rack of javelins. The length of the steel bow is about 18 feet.

weight, and probably was never used at sea. It is mentioned in an account of the naval battle off Dover in 1217, but if any were on board, they were probably going as stores to the French army in England. Nevertheless a brief account may be interesting. The trebuchet consisted of a spar of 40 or 50 feet long mounted on trunnions on a suitable carriage so as to swing in a vertical plane. The trunnions divided the spar into two arms whose lengths were in the ratio of 3 or 4 to 1. The short arm was loaded with a heavy weight which sometimes reached or exceeded 20,000 pounds. The long arm carried the missile which weighed not over 5 per cent of the counterweight and seldom as much. The range was much increased if the weight was put in a sling attached to the head of the long arm instead of having a spoon to hold it. The long arm was hauled down to the ground by a suitable tackle and held by a triphook, so that the counterweight was upheld at an angle of about 45°. The sling was then attached to the arm and laid along the ground with the missile towards the trunnions. When the hook was released, the long arm flew up under the pull of the counterweight and when a certain velocity was reached the centrifugal force caused one leg of the sling to slip off a toe which held it and the stone entered on free flight. In this weapon, which depended on gravity for its energy, it is apparent that the length of the short arm was the primary factor in determining the range. The velocity of the projectile depended on the size of the counterweight and the ratio of the long and short arms. If the ratio was more than 4 to 1, the center of gravity of the whole system would approach too near the trunnions and the efficiency would rapidly diminish. Sir Ralph Payne-Gallwey carried out trials with trebuchets built by himself and believes that a heavy trebuchet could hurl a weight of 300 pounds as far as 300 yards.

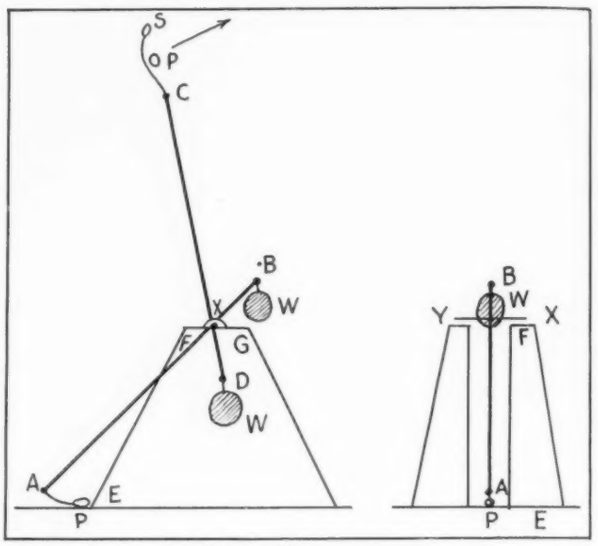


FIG. 7. TREBUCHET.

Right: Diagramatic view in plane of fire; left: diagramatic view across plane of fire. Legend: EFGH, mount; AB, throwing spar ready to fire; P, projectile in sling; W, motive counterweight; CD, throwing spar, releasing projectile; CPS, sling and projectile at release; XY, axle.

WE may now turn to the early weapons using gunpowder as the motive force. The earliest mention of gunpowder for cannon in Europe was in 1326 when the city of Florence had some. Apparently saltpeter had been used in incendiary fireworks and it had been found that the gas generated by the saltpeter drove the fire ball. Then the mixture of saltpeter, sulphur and charcoal known as gunpowder was used to drive projectiles. It seems probable that the earliest missiles driven by gunpowder were crossbow bolts or arrows with very small charges.

To get an idea of how these early weapons compared in range and striking power with arrows and crossbow bolts, we must first see what was the energy in one pound of powder. Really scientific work in ballistics began in the middle of the 18th century. From the work of Robins it appears that at that time one pound of the new well-incorporated type of

FIG. 6. MECHANICAL THROWER (BALL) MOUNTED ON CASTLE ST. ANGELO, ROME.

The ball missiles are shown at right. The length of the steel bow is about 18 feet.

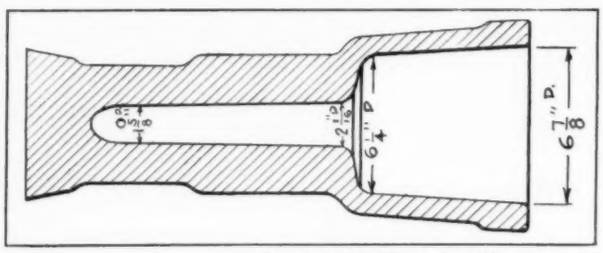
FIG. 8. FIFTEENTH CENTURY BRONZE GUN NOW AT THE TOWER OF LONDON.

Caliber, 25 inches; weight of stone shot, 60 pounds. The gun is in two pieces which screw together. The cog teeth in four rows around the circumference are to take levers for assembling the two parts together. The powder chamber in the rear part is only 10 inches in diameter but is large enough for 200 pounds of powder. The bore forward of the powder chamber is 110 inches in length of 4.4 calibers. The probable initial velocity with 150-pound charge is 700-750 foot seconds.

"corned" powder developed about 60 foot-tons per pound in a 24-pounder gun of 19 calibers in length of bore, and 16 pounds in the same gun developed about 28.3 foot-tons per pound. The older type of powder known as "serpentine," which was less thoroughly mixed, had only about 6/7 the strength. But the very early powders were still less efficient, for they were often mixed only at the time of use, were of impure materials, and were much affected by dampness as they readily absorbed moisture. So the efficiency of the earliest powders varied very much and we may assume that different lots may have had an efficiency of from 3/4 to 1/2 or less of that of good 18th century powder. Moreover, the early guns and projectiles were very imperfect in manufacture. The bores were not true and varied between one gun and another nominally of the same size, and many of the bores were slightly coned so that the muzzles were of greater diameter than at the chamber. The stone balls were irregular in shape, diameter and weight, so that the gun and projectile may be held to vary from 7/8 to 2/3 the efficiency of the 18th century, and we may believe that in the same army at the same time the efficiency of the adjoining batteries of two master gunners may have varied from 2/3 to 1/3 or less of guns of later times. An early English account still preserved shows that in 1338 two pounds of powder provided for 48 rounds of arrow projectiles, and in the same year (see Oman's History of the Art of War, Vol. 2, p. 214) a French fleet raiding Southampton had one *pot-de-fer* with 3 pounds of gunpowder and 48 heavy bolts with iron feathers. So the charge was about one ounce. The weight of the projectile is not given. Considering the *pot-de-fer* for a moderate length of 20 or 30 inches it may have had an efficiency of from 15 to 25 foot-tons per pound of powder. Taking the higher estimate, the one-ounce charge would give 3500 foot-pounds. If we assume that a heavy bolt with iron feathers weighed as much as 10 ounces, the velocity would be 600 foot-seconds. With poorer powder the velocity might be 450 foot-seconds. This discussion can not pretend to accuracy, but it suggests that the first missiles driven by gunpowder probably were much inferior in energy to heavy mechanical artillery, but a superior velocity gave them greater range, how much we can only guess; perhaps 700 or 800 yards, extreme. Novelty was a psychologic advantage.

The size and power of guns rapidly increased, but it was two centuries before a serviceable hand gun was developed. At first guns were used for siege-work. They lay on the ground and were wedged up to give elevation. Sometimes they were attached to wooden timbers to facilitate pointing. In his "History of the Papal Navy" Guglielmotti quotes Bishop Leonardo Giustiniani, who saw a huge gun in one piece used at the siege of Constantinople (1453), which needed 70 span of oxen to draw it and whose stone shot weighed 1350 pounds. A span of oxen was good for drawing a load of 750 pounds; less rather than more. The gun may have weighed nearly 50,000 pounds. The Bishop measured the circumference of the shot by 11 spans of his own hands (which means about 31 inches diameter) and says the gun fired 7 or 8 times a day and once at night. If we do not accept this testimony, there is today in the Tower of London a bronze gun of 25 inches caliber, of the same period, made in two pieces, weighing 17.7 tons (Fig. 8). The breech-piece screws into the chase, whose length is 110 inches or 4.4 calibers. The bore of the breech-piece is 10 inches and the chamber is 70 inches deep, able to hold about 200 pounds of powder. The projectile lying by it is 24.2 inches in diameter and presumably weighs 650 or 700 pounds. If we suppose the charge was 150 pounds, the velocity of the stone shot might be 700 foot-seconds, more or less, and range 2200-2300 yards at extreme elevation, but as a siege gun it needed only to be beyond archery range from the walls and this called for no more than 6°-8° elevation.

Guns were early used on shipboard. Small mortars, called bombards, of 6 inches in diameter and of only 8 to 12 inches length of bore, fired stone shot of about 10 or 11 pounds. The picture and drawing (Fig. 9) of a single-piece, cast-iron gun in the Metropolitan Museum show a main bore 7.5 inches long, with a caliber of 6¼ inches and powder-chamber at the rear of the main body of the gun. It is mounted on a wooden pedestal shaped into a fork to carry the trunnions. The chamber capacity of this gun was about 17½ ozs. of powder. Loaded with 14 ounces, we may believe that it would not yield more than 9-12 foot-tons on account of weak powder and the flaring shape of the bore. It would give a velocity of under 400 foot-seconds at the most to a 10-pound projectile.



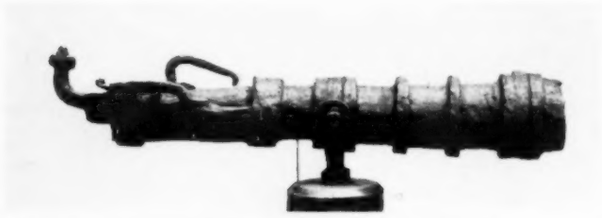
Courtesy of the Metropolitan Museum of Art

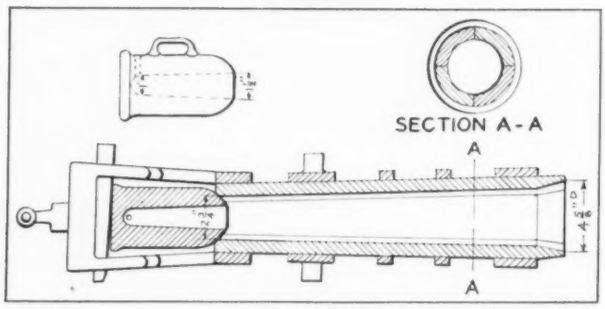
FIG. 9. EARLY BOMBARD ON NAVAL MOUNT.

This bombard or mortar is a solid iron casting weighing 150 pounds firing a 10 pound stone ball. The probable initial velocity with 14 ounces of powder was about 360-390 foot seconds.

Fig. 10 shows a type of breech-loader which was much used in the 16th century on shipboard. It is a built-up gun, and has two or more detachable powder chambers, whose capacity is 8 cubic inches. These were loaded in the magazine and washed out after each discharge before going below again. This gun is 22 inches long in the bore, which is 2¾ inches in diameter at the rear, increasing at the muzzle to 4-5/8 inches. With a stone shot of 14 ounces and a charge of 0.25 pounds it might reach a velocity of 700-800 foot-seconds, but the very great enlargement of the bore towards the muzzle makes a close estimate difficult. Figure 11 is a built-up muzzle loader.

On board the galleys the largest guns were 40-pounders.

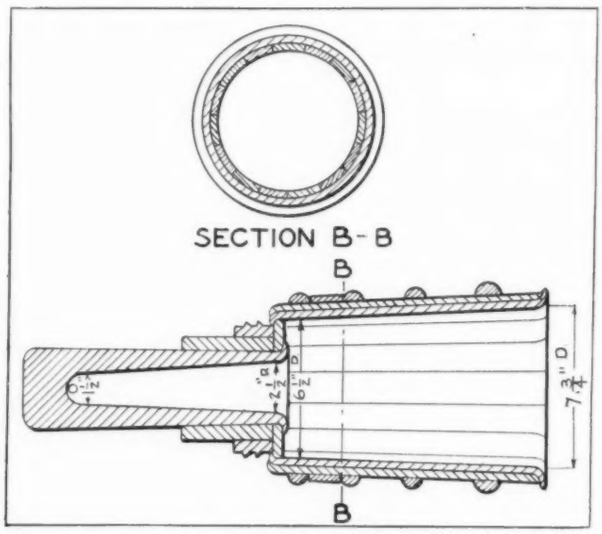




Courtesy of the Metropolitan Museum of Art

FIG. 10. SIXTEENTH CENTURY BREECH LOADER.

This breech loader is built up of longitudinal bars and hoops. It weighs 140 pounds and fires a ¾-pound stone ball. It consists of 4 staves bent into quadrants to form the body of the gun. These are bound together by hoops. The flare of the bore permits a variation of 3 or 4 degrees in the course of the projectile while still within the gun and the loss by windage is very great so that the estimate (see text) of an initial velocity of 700-800 foot seconds for a quarter pound charge is high.



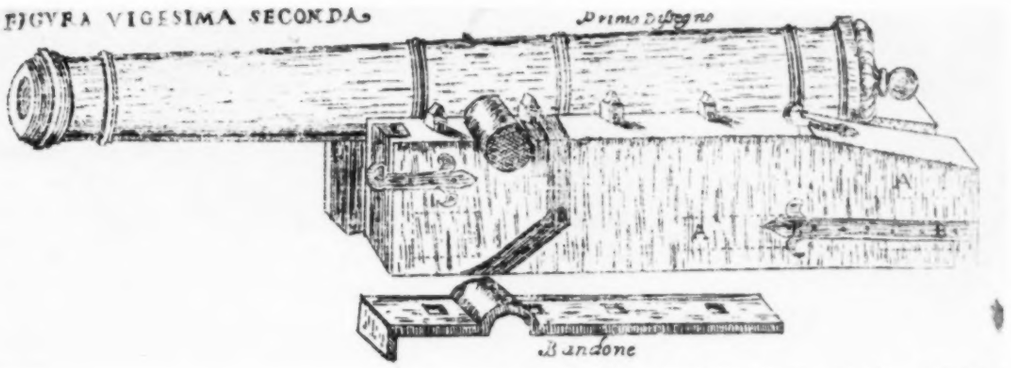
Courtesy of the Metropolitan Museum of Art

FIG. 11. MUZZLE LOADING BOMBARD.

This bombard or mortar is built up of longitudinal bars and hoops. It weighs 145 pounds and fires a 10-pound stone ball. The length of the bore is 12½ inches; diameter of the bore: at rear, 6½ inches; at muzzle, 7¾ inches. Dimensions of the powder chamber are: length, 10 inches; diameter, 1½-2½ inches; contents, 32 cubic inches; powder charge, about 1 pound; initial velocity perhaps 420 foot seconds.

The method of building is noteworthy. The powder chamber is flanged at its mouth and catches on a disc which forms the bottom of the bore. The longitudinal bars are bent at the ends to hook over the disc and these are hooped by an iron cylinder to take the bursting strain. The hoops outside the cylinder are shrunk on.

Occasionally they were 60-pounders. There was only one gun of this size, firing directly ahead (Fig. 12). It was fastened solidly to a timber cradle which had a long recoil between timber guides fastened to the deck and was stopped when it hit the mast, which was protected by rope mats. Pointing was done by the helm and the early guns had point blank fire only, as there was no means of elevation. On each side of the big gun were one or two other guns of smaller size, 24



Reproduced from L'Artiglieria di Pietro di Sardi, published 1689

FIG. 12. A 37-POUNDER BRONZE GUN OF THE SEVENTEENTH CENTURY.

This weapon is known as the "corsia" type, that is the heavy gun of a galley. It can be given slight elevation, earlier designs being fastened solidly to their cradles. It is of the cannon type, that is about 20 calibers long with a powder charge two-thirds the weight of the projectile.

pounders and 15 pounders or less and similarly mounted. The broadside guns were comparatively small and were mounted so as to be trained. In addition to these guns small ones were placed at the break of the poop and the forecastle to command the waist of the ship for the purpose of repelling boarders.

SAILING ships were not effective men-of-war until the 16th century and were armed with small guns on the upper deck only, for defense against pirates. After the discovery of America and the passage to India around Africa made the control of the sea too difficult for rowing ships and sail-power replaced oars in effective men-of-war, ports were cut to the lower decks of ships and additional guns were mounted there. Iron slowly replaced stone as the usual material for projectiles, although stone was used in the 17th century. The 42-pounder was the largest gun in general service afloat, although we occasionally hear of a 60-pounder. In the 16th century the mounts for guns afloat became substantially what they were until the middle of the last century, namely, heavy wooden carriages mounted on four small, wooden wheels, but they were never capable of much train or elevation, for the ports were always small (Fig. 13). The rate of fire was always slow, although the time for loading can not have been very different from what it was for muzzle-loading guns in later times, namely, about 30 to 45 seconds per round. In the campaign of the Great Armada in 1588, which was decided wholly by gunfire, the fighting on the last day was the heaviest and continued all day, yet the English expenditure of ammunition seems to have been only about sixteen rounds, with a very small percentage of hits; from such slight indications as have come to us in the records, under 10 per cent at ranges of 75-200 yards, probably much less.

It is an interesting point in the history of warfare which corresponds to industrial development, that as the mechanical power of weapons increased, the number of men employed per ton of shipping decreased. At Lepanto in 1571 nearly 150,000 combatants manned 460 fighting ships of about 70,000 tons displacement, and the battle was decided hand-to-hand. Seventeen years later the Anglo-Spanish campaign in the English Channel was fought exclusively by artillery, and it seems only some sixty ships of about 77,000 tons displacement, with some seventeen to eighteen thousand men, were seriously engaged, although the records name as having taken part over three hundred vessels of about 175-900 thousand tons displacement, with over forty thousand men. Moreover, the English, who had entirely gone over to the artillery battle, had batteries about three times as heavy per ton and two and a half times as heavy per man of crew as the Spaniards, who still relied chiefly on boarding.

I am much indebted to Mr. S. V. Grancsay, Curator of Armor at the Metropolitan Museum of Art in New York, for drawings and measurements of the crossbows and guns mentioned in this paper, and permission to publish them.

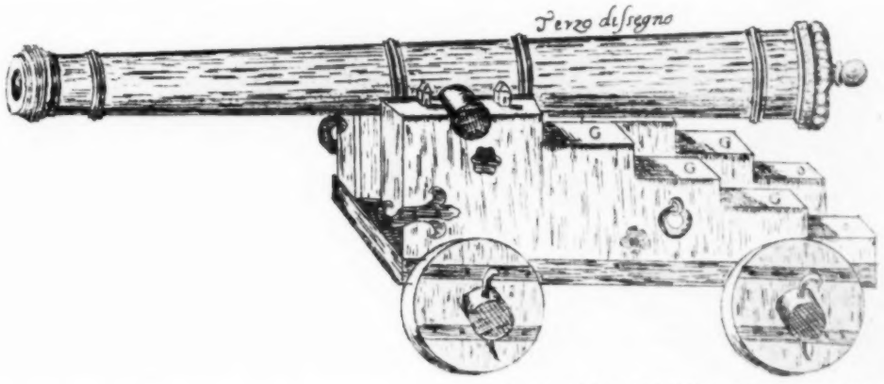


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FIG. 13. A BROADSIDE GUN OF THE SEVENTEENTH CENTURY.

This gun was for use on sailing ships of high freeboard. It is a cannon type, its caliber 3.8 to 4.8 inches; weight of projectile, 7.5 to 15 pounds. Chocks were placed at various stages marked G for elevation.

The End of Disarmament

Further Efforts for Limitation Must Be Realistic

By Sir Charles Petrie*

WHATEVER its ultimate repercussions may be, the reintroduction of conscription in Germany has served the useful purpose of making the world open its eyes to the realities of its situation. In our grandfathers' days it was considered only modest to pretend that women did not possess legs, and stories are told of elderly spinsters who even, in their excessive regard for virtue, covered up the legs of their pianos. The passage of time put an end to this particular hypocrisy, and it was freely admitted that women had legs, without anyone being the worse. So it is with armaments: after having for years carefully ignored the steady increase of armaments in nearly every country, public opinion, even in Great Britain, has now been forced to admit that it has taken place. This, at any rate, is a step in the right direction, and affords some solid ground for hope. However, before considering what is likely to happen in the future, it is necessary to examine somewhat closely why all efforts to secure agreement among the Powers have so far failed, and to see what lessons may profitably be learnt from this failure.

In the first place there can be little doubt but that all over the world politicians and the Press encouraged the public to place their hopes far too high. The result was that the Disarmament Conference at Geneva opened, in February, 1932, in an atmosphere more suited to a revivalist meeting. Petitions in favor of disarmament, alleged to contain millions of signatures, literally poured in upon the Conference, and, as an onlooker described it, "the President (i. e. Mr. Arthur Henderson) leant over from his dais, and smiled as the mountain grew." This incident is typical of the attitude which was deliberately fostered at the time, and it is no exaggeration to say that the ordinary citizen, at any rate in Great Britain and the United States, was led to believe that within a few weeks of the coming together of so many high-souled idealists the beating of swords into ploughshares would be complete. The superstitious might have known better, for the first plenary session of the Conference had to be postponed for an hour while the Council of the League of Nations discussed the Japanese bombardment of Shanghai; which was hardly a favorable omen. As Mr. Wheeler-Bennett so well puts it in that admirable work, *The Disarmament Deadlock*, "Even as Gibbon dates the Decline and Fall of the Roman Empire from the reign of the first Emperor, so did the decline of the Disarmament Conference begin at its opening session."

MUDDLED thinking, sometimes unintentional but not infrequently deliberately encouraged by those in authority, is at the bottom of many of our troubles today, and the armament problem is no exception. Had the world's statesmen said clearly at the beginning that disarmament was not practical politics, and that it was to limitation that attention should be directed in the first instance, then this excessive—and harmful—optimism would have been avoided. In an atmosphere of realities, limitation by agreement might well have been reached, and so a universal feeling of security would have been engendered. Once that had been produced, the way would have been clear for a discussion on the next step, namely, the reduction of armaments. Whether this course was not taken because those concerned were too stupid to adopt it, or too cowardly to tell the public the facts, is beside the point. What happened was that everyone moved for a short space in a world of make-believe, and when they realized all was not so roseate as it seemed there was a reaction to the depths of despair. If another war comes there will be a lot for which the politicians and the Press will have to answer, and the inculcation of unjustified optimism, often for reasons which do not bear scrutiny, will not be the lightest charge.

Furthermore, what should surely have been clear from the beginning is that armaments are dependent upon policy, not policy on armaments. Every nation must be armed in a world where all human law ultimately rests upon force; but excessive armaments are caused by fear, which, in its turn, can only be removed by the pursuit of an enlightened policy. The greater part of the human race today is gripped by a terror unknown in history; yet there was a moment, just after the signature of the Locarno Pact in 1925, when the tension was relaxed. Moreover, the economic blizzard had not yet begun to blow, and men all over the world were more contented than they have been before or since during the post-war period. Then, if ever, was the opportunity to bring about a limitation, if not a reduction, of armaments; but it was allowed to pass. The situation, economic as well as political, was suffered to go from bad to worse; then, in the middle of the crisis, the cart was put before the horse, and the Disarmament Conference convoked to undo the ill effects of bad politics. By 1932 all the old fear had come back again, and there was not the slightest chance of securing disarmament in the existing political situation.

Such being the case it is hardly surprising that each Power tried to use the Conference as a means of disarming those of its neighbors of whom it was particularly frightened. The States that were specially exposed to air attack advocated the abolition of the airplane in war, while those which were dependent upon imported foodstuffs could hardly find words strong enough to express their detestation of the submarine as a relic of barbarism. Like self-determination, minority rights, sanctity of treaties, and a dozen other catchwords of the present age, disarmament was regarded by every government as a very handy weapon for use against its enemies. At the same time, there were occasions when strong leadership could have brought about an agreement. Such a one presented itself in April, 1932, when Germany proposed that in return for an undertaking not to increase her armaments for five years, or until the second Disarmament Conference, she should be allowed to reduce the term of service in the *Reichswehr* from twelve years to five; to organize a militia, which should not exceed the number of 100,000 men allowed to the *Reichswehr* by the Treaty of Versailles; and to obtain her release from the restrictions imposed by the Treaty on the

*Foreign Editor, *The English Review*, London.

purchase of war material. Dr. Brüning, then German Chancellor, also asked that the prohibition of his country's possession of weapons of offense should be abrogated, but said that Germany was quite willing to renounce this type of armament on condition that all the other Powers did the same.

This represented the high-water mark of the Conference. The German offer met with the approval of the United States, Great Britain, and Italy, but M. Tardieu, the French Prime Minister, would not even come to Geneva to discuss it. Had Mr. Ramsay MacDonald possessed an ounce of firmness he would have told France that she must either come into line with the other Great Powers, or stand exposed as the real obstacle to disarmament. This must have made her show her hand. He did nothing of the kind, but allowed M. Tardieu to wreck the whole scheme by his opposition. Since then Mr. MacDonald has kept that particular negotiation shrouded in mystery, and has obviously regarded any allusion to it as an act of impertinence. As a recent writer has put it, "What a chance was here for statesmanship, what an opportunity for the British Prime Minister to take the lead in Europe." He is not, however, that sort of man, and poor Dr. Brüning, rebuffed, went back to Berlin and defeat.

AT this point it may well be asked by the man-in-the-street what useful purpose (apart, that is to say, from providing a comfortable income for Mr. Arthur Henderson, the President) has been served by keeping alive a Conference which is so manifestly incapable of reaching a successful conclusion. The answer is that no Power has wished to accept responsibility for terminating its proceedings. Since the war, foreign policy has in most countries been under the influence of the domestic political situation, and no government has wished to offend that well-meaning, but decidedly woolly-minded, section of its electorate which thinks that because a so-called Disarmament Conference is in existence the world must necessarily be getting nearer to disarmament. Whether the German decision to reintroduce conscription will now give the Powers an opportunity of laying the baby on the doorstep of Berlin remains, at the moment of writing, to be seen.

It was also not a little unfortunate that two notable examples of the successful use of force should have been given during these years. In defiance of Geneva the Japanese set up Manchukuo, and when they were censured they resigned from the League, which found itself quite powerless to do anything except utter pious platitudes. In July, 1934, Dr. Dollfuss, the Austrian Chancellor, was murdered, and there was imminent danger of a German invasion of Austria, where the local Nazis had raised an armed revolt. This was only prevented by the concentration of a very strong Italian force on the Austrian frontier, and by the evident determination of Signor Mussolini to use it if the Germans made any forward move. The contrast was striking between the failure of talk at Geneva to arrest the Japanese advance, and the success of Italian bayonets in keeping the Germans out of Vienna.

It is no use crying over spilt milk, and disarmament is not practical politics today. At the same time, no one wishes to see the nations of the world plunging into an armaments race which they cannot afford, and which must inevitably lead to another war. The only solution is to cease following the will-o'-the-wisp of disarmament, and to see what is possible in the matter of limitation of armaments.

The facts of the situation must first be considered, and they have become abundantly clear during the last few weeks. The immediate post-war system has broken down, and the nations are feverishly searching for something to put in its place. To those with any knowledge of history it had been obvious for some time that the settlement of 1919-20 could not last much longer, but the revival of Germany has been more rapid than at one time seemed possible, and now the collapse of the old order has taken place. This order was the domination of Europe by France and her allies, that is to say Poland and the Little Entente, with the tacit consent of Great Britain. Its maintenance depended upon the subordination of Germany as arranged by the Treaty of Versailles, and in particular upon her compulsory disarmament. Today all that is a thing of the past. The German army is once again the dominating military factor on the Continent; Poland is the friend of Germany; and the Little Entente is trying to make up its mind between the Habsburgs and Hitler in Vienna, that is between the two policies against which it has fought for sixteen years. Such is the measure of the statesmanship of M. Beneš and M. Titulesco. In addition, France, in a state of panic, is flirting with Russia; while Great Britain, annoyed because she cannot wash her hands of the Continent altogether, hesitates to enter into any commitments that may have political repercussions at home. It is beside the point to regret this state of affairs, and to sigh for the golden days of Versailles. They are gone forever.

It must unfortunately be admitted that the policy, or rather lack of policy, of Great Britain in the matter of security or disarmament has had much to do with the existing unrest. The Locarno Treaty represented the highest point of British prestige since the war, but its effects were negatived from the beginning by the fiasco over Germany's entry to the League, and were subsequently nullified by the long farce of the Disarmament Conference. Such an attitude as that of Mr. MacDonald, already described, made it apparent that Great Britain had no policy, and was only concerned to negotiate a formula which would concede to Germany the shadow of equality, while leaving France with the substance of effecting military superiority. This meant making the worst of both worlds, and British statesmen adopted such a course because they feared to keep public opinion at home abreast of the realities of the European situation.

IT has already been suggested that armaments depend upon policy. A famous French Minister of Finance once told his King, "You make good politics, and I will make good finance," and this observation was a very shrewd one. Without a satisfactory policy there can be no disarmament. The same applies to limitation, which is the only possible goal at the moment; for there will be no hope of reaching even that unless the ground has previously been cleared of at least some of the major political issues at stake. At this point it may be as well to make a reservation, which is that it is quite useless to search for one particular formula of peace that shall be suitable for all conditions. Many of the failures in the past have been due to such a mistaken line of conduct. Instead of concentrating upon the more local, but equally more immediate, issues, statesmen have preferred to attempt to evolve a new order that shall cover the whole world from China to Peru. In the matter of disarmament this has meant an arbitrary measurement of every nation's needs. It cannot be too strongly stated that there must be a complete break with this type of procedure if any advance is to be made. Nor will any useful purpose be served by imagining that there is a

change of heart among the various peoples of the world. For some years after the late war we were bidden to look upon the contrast between the older generation, cynical and bellicose, and the younger, pacifist to the core and inspired by a love of humanity that took no account of frontiers. That mirage has faded, and in its place we have youth, nationalist and aggressive, determined that in the struggle for power the weaker shall go to the wall. The doctrines of Nietzsche, not the teaching of the Sermon on the Mount, are the gospel of the fourth decade of the twentieth century.

Democracy may or may not be favorable to the preservation of peace, though its record in this connection is certainly not very encouraging, but that has little bearing upon the present question, because the modern world is deliberately rejecting democracy of the old type whenever an opportunity occurs. The recent plebiscite in the Saar was a case in point. The vast majority of that electorate deliberately voted in favor of incorporation in Nazi Germany rather than of remaining under the control of the League of Nations, in spite of all the safeguards for the liberty of the subject which the latter choice would have implied. In effect, democracy is being defeated with the very weapon which it forged, namely, universal suffrage. In the immediate future, which is all that need concern us at the moment, we shall therefore continue to be confronted, probably to an increased extent, with a nationalism that has pervaded every sphere of human activity. In the matter of armaments the nationalism will demand, as Germany and Japan have already done, a scale commensurate with the national needs, and these needs, in their turn, will depend upon the general state of the world. In other words, there is going to be a good deal more realism in international politics in the future than there has been in the immediate past, and that may well prove to be no bad thing in the long run.

IN these circumstances limitation of armaments will only be possible if the nations are convinced that there is such a thing as international justice. There has been far too much talk of peace of late years, and far too little of justice. Statesmen seem to think they have done all that is necessary when they place an embargo on the sending of munitions to some third-rate Power, which probably could no longer afford to pay for them anyhow. This is not enough. Every self-respecting nation will continue armed to the teeth unless it is convinced that it can secure justice by some other means than its own sword. The League of Nations in its present form does not serve this purpose, as its handling of the recent dispute between Hungary and Jugo-Slavia abundantly testifies. The unedifying spectacle of M. Beneš descending from the Presidential chair to sit beside the protagonists in the dispute was the logical result of trying to convert a political assembly into a judicial body. What is required is a panel of arbiters, who shall be neither politicians nor lawyers, to whom questions, not suitable for The Hague tribunal, can be referred, and who will base their decisions on considerations of equity. Politics are the business of the Council and the Assembly, and law is that of the Permanent Court of International Justice, but there are many problems which are not legal in their nature, and should not be made political. A great step forward will have been taken in the direction of the pacific settlement of disputes when a board of arbitration has been established. It might also concern itself with Article 19 of the League Covenant, which deals with the revision of obsolescent treaties.

The establishment of new machinery of this nature would remove one of the most potent causes of unrest, and would enable the nations to assess their needs far more easily than at present. Of course there will always be wars, but wise statesmanship can limit both their number and their scope. First of all, the resources of diplomacy must be utilized to smooth away difficulties, and the interview in Rome at the beginning of the present year between Signor Mussolini and M. Laval shows what can be done by two men who know their own minds. It will clearly be impossible to remove every cause of friction, but a good deal can certainly be done if only the attempt is not made on too large a scale. Once this has been accomplished, let each nation fix its armaments at the level it believes to be best suited to its needs. There can be no uniform scale, at any rate in matters of detail, as has been pointed out above. It is quite useless trying to assess the value of a British mountain battery on the North-West frontier of India in terms of Dutch tanks or Polish cavalry. Every State must decide for itself what it requires, but when that has been done there is no reason why all should not agree to keep their armaments at such a level. It will be the duty of the politicians to see that international complications do not arise to render an upward revision essential. If they do their work properly, it should be possible after the lapse of a reasonable interval to secure agreement on a ten per cent cut in expenditure. This would be the beginning of real disarmament.

It would be difficult to emphasize too strongly the necessity of approaching the problem from a new angle if there is to be any hope of success. The whole armament question has too long been the sport of sentimentalists, and treated as if it were on the same footing as the White Slave Traffic. There is nothing immoral in armaments themselves, it is the use to which they may be put that is immoral, but that is the affair of the politicians. In effect, it is not a problem of sentiment, but one of hard facts. The maker of armaments is merely meeting a demand like the manufacturer of any other class of goods, and the fact that at the present time there is a large demand for his products is due to the failure of the politicians to bring real peace to a harassed world. Once again, it is not armaments that breed fear, but fear that breeds armaments. One would have thought this was obvious; yet it is the obvious that generally escapes notice today.

One of the leading figures in British public life, Sir Robert Horne, said the other day in reference to the reintroduction of conscription in Germany, "We can now go forward to negotiations in terms of reality." It is most sincerely to be hoped that this advice will be taken, not least in Great Britain itself, where there is always a disposition to avoid facing facts save in the very last resort. There is a chance now of effecting a settlement on a basis of realism, but it is first of all necessary to assimilate the lessons of the failure of every previous attempt at disarmament.

The Index to Army Ordnance, Vol. XV, which concludes with this issue, is now in preparation.
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Production Design of Ordnance

Precise Drawings and Specifications are Essential

By J. D. Pedersen*

THE elements to be considered in the design of ordnance matériel are essentially the same as those in the design of any similar mechanism when volume of production warrants the most efficient manufacturing equipment. But, so far, neither in the production of ordnance matériel nor in industry in general, has adequate study been devoted to designing the component parts with the express purpose of facilitating their mass production. Such study should follow and be a development upon the inventor's design. In this paper it will be called *Production Design*.

It is not our machine tools, nor our knowledge of fixturing and gaging which is generally inadequate. Our weakness, which lies farther back, is in the drawings supposed to specify exactly *what* each component should be. Most drawings depict little more than the simple abstract or idealized component which unfortunately cannot be produced by known manufacturing processes. These drawings fail to state completely the limits of variations which will produce functioning and interchangeability.

This is due to the customary practice of delegating to the draftsman, rather than to an expert production engineer, the responsibility of making the component drawings. Such drawings are frequently dimensioned from some hypothetical center line or other reference point convenient to the draftsman, despite the fact that these points will not be used for locating in fixture and gage during manufacture. In some drawings several different reference points may be found for one component. The result is analagous to that obtained by the amateur workman who, in sawing off boards for a picket fence, uses the most recently sawed picket as a measure for the next, and finds that the final picket has acquired surprising stature. In ordnance matériel no pains should be spared to reduce the design to the forms best adapted to production, and to define precisely *what* each component shall be.

WARS generally come suddenly. They catch us with an inadequate supply, usually with little more than pilot models, of the weapons we contemplate using. Contracts are let in vast numbers. Factories are improvised and the work on special manufacturing equipment is started. Organizations are hurriedly augmented, necessarily with a large portion of labor and superintendence generally ignorant of the product to be made. There is no time to deliberate on details of design. Action is demanded. Zeal too frequently is substituted for ability. The whole nation is crying for guns, at once. This is exemplified by a picture typical of production during the Great War.

A factory receives production orders and component drawings along with one or more models of the firearm desired. The models function well in themselves, their components readily interchanging from one to the other. But, upon measuring these components, it is found that in many particulars they do not agree with the drawings nor among themselves. Frequently the drawings carry tolerances difficult to procure under mass production methods. Attempt is made to reconcile models and drawings and finally to establish production or manufacturing limits. Correct limits are applied easily enough in the case of simple male and female engagements; also in case of surfaces requiring only an "atmospheric fit." However, in the attempt to determine the tolerance accumulations in a functional train involving several components we begin to bog down. Accumulated variations mount up alarmingly, and many tolerances are set which later prove unfeasible. The main fault is the *arbitrary* setting of limits which later fail to produce either interchangeability or functioning.

Many tolerances are set at "round table" conferences. The inventor groans if a variation of more than a thousandth of an inch is suggested, while the milling department foreman fights for ten times that amount. However it may be, tolerances *are* set, component drawings brought up to date and the special equipment of fixtures, gages and cutting tools designed and built. So far, in spite of many small difficulties, all has seemed fairly clear sailing, and hope is strong that the impending production schedule will be met.

As delivery begins on the special equipment, the fixtures are set up on their belted machines and tried out. Certain operations do not produce to gage. These require changes. Certain other operations produce to gage only by careful "nursing" of the operation. "Let's go—we must meet the production schedule." Finally, the first components seem ready to assemble.

In the assembling department, however, the sins of faulty production design now overtake us. Some parts will not assemble without being changed; affected surfaces are outside their gage limits; other components will not assemble, although they are everywhere within their gage limits. A few guns may assemble without special adjustment, but they do not perform satisfactorily the required functions. Apprehension justly arises that the components have not been correctly specified. But, the head office continues to be cruelly insistent about "guns in the shipping cases."

We now begin to realize the import of the word "trouble." A detachment of "trouble shooters" is hastily organized, many suggestions considered, some adopted, and changes to equipment are started. The production schedule has already been "badly bent" but hope lingers that by extra effort we can yet swing in with the final quota. The necessity of frequent "explainings" to the head office does not add to our peace of mind or ability to secure results. Yet important decisions must be made, for—to continue machining may accumulate a mass of useless components—to stop will result in no components for the assembling department to practice upon. During the "tuning up" stage, machining on certain components may be stopped and started several times.

Eventually, the components carrying the newly adopted changes come to the assembling. The original troubles seem settled. But now new ones crop out, some as an unexpected

*Ordnance engineer. Designer and inventor of the Pedersen Device and of a number of rifles and shotguns.

result of recent alterations. The necessity of yet more changes develops from time to time. These are made. Matters are improving however, as one by one the troubles are run down.

After much travail, one day it is realized that routine assembling may be started. This soon grows into "guns in the warehouse" in increasing numbers. But many extra months have elapsed and an entirely new production schedule must be set up since there is no hope of meeting the original one. During the entire course of the production, difficulties frequently arise, but we are now more proficient in solving them.

In cases where contracts for the same product are let to several factories, the output of one plant becomes differentiated from that of the others since each factory has its individual troubles and, usually, its own solutions.

Many who have participated in the above picture have concluded that the production travail described is unavoidable. A thorough survey, however, indicates otherwise. We now know that the net result of the changes made was finally the *adoption of attainable tolerances with limits adjusted to secure interchangeability*. But, groping in the dark of cut-and-try methods is time-wasting, costly and inconclusive! Nearly all of these troubles and delays at the start of and during the course of manufacture may be avoided by a competent production design of the components. The feasibility of such a design has been demonstrated more than once.

Ability to manufacture requires an organization of men and machines. Due to the former prevalence of the "Yankee mechanic" and his excellent judgment, a fair though not interchangeable product could be obtained with the use of non-limit gages after a colony of workmen who had become skilled in its product grew up around the plant. But, the "Yankee mechanic" is passing and is being replaced by workmen of lower ability and less zeal. On the other hand, the general trend of development in mechanism is toward greater intricacy, which imposes ever greater demands for uniformity of production.

To permit progress, reconciliation of these opposed conditions can lie only in the perfecting of our technique and in the complete use of limit gages. Limit gaging requires a minimum of skill and judgment on the part of the factory personnel and enables a result not otherwise attainable. However, limit gages are not fully effective unless the limits they measure are themselves correctly determined. Correct production designs, plus adequate methods of fixturing, limit gaging, etc., solve the problems of mass production and of interchangeability. At the same time the most reliable product is secured, at the lowest cost and with the least delay.

IN the mechanism of a small arm there are from 100 to 300 component parts, all but one or two being of steel, usually alloy, or high carbon steel. Many receive heat treatment. Components are machined from forgings or from the solid bar. Many surfaces are formed by second or finishing operations; none are unmachined. In the infantry rifle over 700 distinct machining operations are required for its various components.

To maintain the factory discipline necessary to secure interchangeability and easy mass production, each machining operation must be rigidly inspected. Any component not entirely within its gage limits should be rejected. The tolerance adopted for each operation, therefore, must be readily attainable with the equipment and the class of workmen available during war-time production. Only such tolerances will permit the fair rejection of any work which may be outside its gage limits.

Tolerance may be defined as the zone within which the desired surface must lie completely. The adopted limits bound this zone. Limit dimensions specify the pair of planes, cylinders, spheres, cones, etc., forming the boundaries of the tolerance zone.

On the component drawings the limits bounding these tolerance zones must be defined to permit of one—and only one—construction. As full faith must be given later to every dimension, possibilities of misunderstanding must be avoided. Where necessary, explantory notes should be carried on the drawings.

Experience in volume production of the class under discussion has suggested the following tolerances attainable between proper locating points and the surface considered:

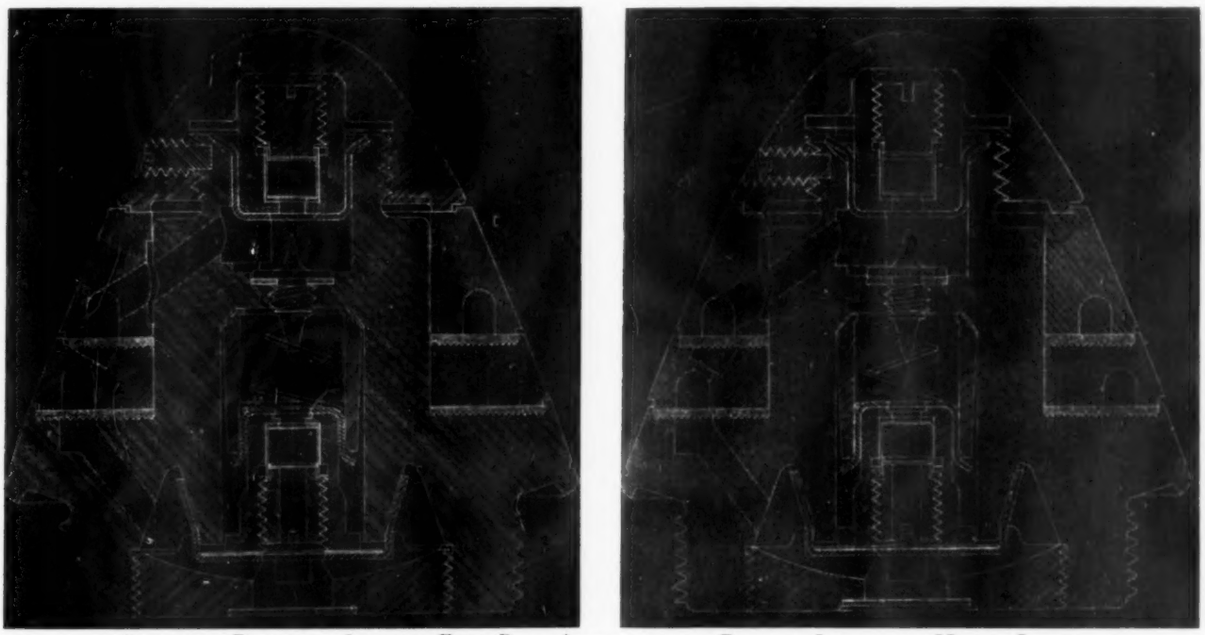
	Tolerance
When surface is formed by milling, profiling, slotting or shaving	″.008
With slightly more care	″.006
With second or finishing operation	″.004
Finishing a small simple spot	″.002
Surface grinding on magnetic chuck	″.003
Greater care and use of revolving chuck	″.002
(Close parallelism can be secured by the latter method)	
Axial position of fairly short jigged holes	″.002
With refined equipment and skill	″.0005
Position of end of milling cut when procured by ordinary "knock off" of power feed	″.030
End of milling or shaving cut if hand fed against stop	″.006
Hand fed with skill against special stop	″.003
Position of shoulders or ends of holes dependent upon ordinary spindle stops	″.015
With greater care	″.006
Skill with special stops	″.002
In the case of generated sizes dependent upon the cutting tool being moved to a stop, such as turning, boring and center grinding, in diameter	″.006
With some care, in diameter	″.004
With skill and refined equipment, in diameter	″.002
Grinding short pieces with skill, in diameter	″.001
In the case of sizes dependent upon the dimensions of the cutting tool these tolerances are readily attainable; width of slots formed by milling, shaving, etc.	″.008
If second cut	″.004
If second cut and tool frequently changed	″.002
Diameter of fairly short holes or stems if drilled or hollow milled	″.004
Single reamed or box tooled	″.002
Second reamed or box tooled	″.001
Second reamed, with skill (as for locating holes or for driving fit)	″.0006
Diameter of long holes such as in rifle barrel where several reamings are done	″.0015
Special care, with some selection	″.0006
Diameter of rifling grooves	″.003
With special care	″.0015

The above list of tolerances, procurable by various methods, should serve as a guide. Special conditions in certain operations may require departures. Experience has shown that, ordinarily, little will be gained by the adoption of tolerances much in excess of those suggested at the larger end of the range. Too great tolerances breed carelessness in production. On the other hand, costs begin to mount increasingly as the smaller end of the range is specified.

Tolerances for mass production are required because of the legitimate variations demanded by the following: (a) Lack of rigidity in belted machine, even in good condition; (b) spring of cutting tool or arbor; (c) adjustment of cutting tool with respect to position and shape or size of tool, and (d) variation due to minute clearance between component locating holes and their locating pins on machining fixture and gage.

Other variations caused by undue spring of cutting tool or arbor, improper locating points on component, faulty design of machining fixture or gage, etc., are not legitimate variations and should be avoided by proper methods and correctly designed equipment.

AS part of its production design each component should be adapted for proper location in its standard machining fixture. Most round pieces can be located naturally on centers, or the like. In the majority of cases, however, the best location is obtained by a plane locating surface on the component. Two holes of ample size and of accurate spacing and diameter



COMPOSITE DRAWINGS SHOWING FUZE BODY ASSEMBLY WITH PARTS TO LOWER AND HIGHER LIMITS.

are carried in and normal to the locating surface. If the component does not functionally require such a plane surface and holes, these locating points should be introduced upon it for machining purposes. Any objectionable portions of the locating points may be removed by a final operation.

The essential element of the best machining fixture consists of a locating plate carrying two locating pins and mounted on the non-movable part of the fixture. The plate is provided with repairable, raised contact spots. The component is moved, in parallel, on to the locating pins to contact with the locating plate, by a movable jaw, preferably driven by a quick action locking cam which holds the work securely under the cutting tool. The work is laid loosely in the open jaw in such a manner that a simple closing of the jaw perfects the correct locating of the component. Opening of the jaw draws the work in parallel off the pins.

In this type of fixture the component is automatically positioned correctly in the second and third planes by the locating pins and the most favorable conditions are provided to correctly position it in the first plane. The chances of error in location are thereby reduced to less than one-eighth of the chances that exist where the workman must exercise his own care to insure correct positioning in all three planes. Best results cannot be expected from the time honoured practice of hammering the work down into a vise.

The fixture adopted as standard for each component can be built in the required number on a small production basis. This reduces the cost below that incurred by building a variety of fixtures for a given component, even though this variety may at first seem expedient. A type or standard fixture for each component also permits a greater concentration of attention to details in fixture design and building. As far as possible position gages for each component should be standardized also.

Reference blocks should be provided for the setting and easy routine checking of the gages required for each operation. Given proper design of the components, production possibility is based upon the integrity of the gages. Both working and inspection gages are subject to wear, according to conditions. A periodic gage inspection of ample frequency should be made a rigid part of production routine. In many cases a good form of reference block can be made from a partly finished component on which the desired machine operation has been accurately formed.

The system of gage checking based upon the use of finished model parts has proven unfeasible. These frequently do not carry their locating points and, in addition, are too much subject to distortion.

In working and inspection gages, a suitable addition should be made to the essential contact surfaces to provide for a reasonable amount of gage wear before the gage must be re-sized. This encroaches upon the tolerance specified on the component drawing. The amount of addition for wear varies in different types and conditions of gage. For instance, a "GO" gage of the snap variety may be subject to more wear than its "NO GO" mate. A simple code to standardize the wear addition to gages of all types may be prepared readily for routine use. Whenever a gage becomes worn the slightest amount outside the limits of its reference block and of the component drawing that gage must be re-sized before further use.

PRODUCTION design involves a preliminary determination of method, fixture and gage for each operation on a component. It permits the balancing of various methods against each other and the selection of the simplest types of

method, fixture and gage which will procure the results desired in each machine operation. It should be made in advance of the final designing and building of the manufacturing equipment. *The saving in time and money thus secured amply justifies this advance preparation.*

Upon the production design of ordnance matériel of the class discussed will depend its excellence of performance, its adaptability to mass production methods and the assurance that several factories will deliver an identical product. Clearly, the final designer of the component parts of the mechanism must have at his finger tips a thorough knowledge of the best methods of machining, fixturing and gaging for each machine operation. Without previous detailed experience in mass production he cannot bring to bear a proper knowledge and decision upon the subject.

In the design no pains should be spared to arrange the surfaces of the components for easy machining and gaging. A limit analysis which embraces the adoption of tolerances unattainable with the methods specified is useless. Full benefit of limit gaging, fixturing, and machining can be attained only when applied to the mass production of a correct design.

Let it be assumed that mass production of a newly-adopted weapon is required. One or more properly functioning models are available, along with the drawings to which these models were made. As the combination of inventor and production designer in one individual is highly unusual, these drawings will rarely serve as an adequate production design. The models only show that a few specially-made guns will function. Therefore, these must be considered merely as a successful laboratory experiment, upon which may be based hopes of mass production of similar mechanisms which will perform the functions demonstrated by the models.

We are now at a stage whose importance is generally overlooked. That the component parts in the models function properly is no proof that similar components made with the variations demanded by mass production methods will correctly assemble in all combinations to perform the intended functions. Such proof can be had only by a mathematical analysis of all possible effects of accumulations of the tolerances demanded by mass production methods.

In the analysis, proper locating points should first be chosen for each component. These points should be made standard for that component and should later be used for all machining operations and all position gaging. Diameter of holes, pins, screws, etc., should also be reduced to the fewest sizes permitted by the requirements.

The drawing for the component parts should clearly specify the locating points and, where necessary, indicate the methods of producing them. The positions of all the elements limiting the tolerance zone of each finished surface should be independently dimensioned from the locating points, except in cases of which the following are examples:

(a) The limit width of a slot to be finished in one setting of the machine is given directly, while the limit location of the desired slot wall is referred to the working points. This arrangement is fairest to the machine adjustor and also enables the use of simple plug gages for width.

(b) A close special relationship between two surfaces formed by separate operations. In this case the best procedure will be outlined later.

It has been argued that on a component, surfaces which are closely related, functionally, should be located one from the other. However, experience has shown that the best results are obtained by locating practically all the surfaces from the standard locating points for that component. If various locating points are used for machining and gaging a component, the resultant maze of tolerance accumulations could not be untangled, in many instances, by even that famed legal expert from the city of Philadelphia. If the same product is desired from more than one plant, it is vital that the identical working points, gaging, etc., be used for the components. Otherwise, the product from one factory will interchange with that from another only by a special dispensation of Providence.

The failure to use the same set of locating points for all the final machining and position gaging operations on a component is bad practice and is effects are insidious. When more than one set of locating points are used, the unavoidable tolerances between the various sets of locating points themselves may very well result in absorbing the allowed tolerances on the surfaces affected. Investigation of such cases has often revealed a condition which left to the actual operation "less than no tolerance." Good engineering should not waste or absorb any of the permissible tolerances. All of these should be given, as intended, to the actual machining operations.

Having determined the locating points of a component and the method of obtaining them, the general characteristics of the machining fixture, standard for the component, should next be determined. Occasionally it is found that a rearrangement of the locating points from those first considered will aid greatly in simplifying the design of the machining fixture. Adequate locating points are always paramount, however, to compactness or simplicity of fixture.

CHOOSING of tolerances and limit analysis should be concurrent with the progress of the drawings. The adoption of attainable tolerances and the correct analysis of their effect under all combinations of their limits is the crux of interchangeable manufacturing and mass production. Attempt should be made to adhere, as closely as functional conditions will permit, to the large end of the tolerance range suggested in this article. In analysis, the simple male and female engagements may first be solved; then the surfaces entering into only limited functional trains; and last, the surfaces entering into all the functional trains for that component. As the tolerance of each surface involved adds to the total variation accumulated through a functional train, it is generally desirable to shorten these trains as much as possible in the design.

Frequently several components are involved in a functional train, also several different trains may involve a particular component. All possible ramifications of these combinations must be traced out and considered.

In analysis, both the maximum and minimum limits should be carried through in the equations. Functional and other requirements must be fulfilled throughout a mechanical train by the opposed conditions of maxima and minima. This proof assures that all possible combinations of the involved surfaces, when anywhere within their respective limits, will always satisfy the requirements. It therefore follows that any place within these limits will be functionally as satisfactory as any other, and no preference need be expressed regarding desirability of machining a given surface to its "high" or to its "low" limit. "Middle of the limits," however, is a good slogan for the production departments.

Occasionally in analysis, it will appear that a function of the mechanism requires tolerances so small as to greatly in-

crease the cost of production and of interchangeability. In such a case the portions involved should be redesigned to permit easily obtainable tolerances. If a satisfactory change cannot be discovered and minute tolerances must be accepted, then a special method to insure the precision demanded should be determined and specified. We must not step over such a point calmly and trust that somehow during production the gods will be kind. Additional delay and expense will be incurred if the prospective trouble is not solved in advance. The gods do not especially favor production engineers.

In analyzing limits, it should be borne in mind that necessary clearance between parts is as definite a function as the required operative contact. This is particularly important in firearms where the demands of conventional contour sharply limits the room for mechanism. Lack of room must ever be faced by the firearms inventor.

With limit analysis should go the preparation of the necessary diagrams. These should show graphically, for each function, the extreme conditions of contact or clearance resultant from the maxima and minima of the involved surfaces. Basic figures for points of departure should be given. On these diagrams should be expressed the direct limit dimensions adopted for each surface concerned; also, step by step, the accumulating resultant limits through the particular mechanism train considered. The resultant limits should be marked so as to distinguish them clearly from the direct limits. Basic dimensions should carry no limits and are identified by a different mark.

These diagrams, with the basic dimensions and figures expressing both direct and resultant limits are the record sheets, or "bible," of the limits analysis. The diagrams should be made carefully and preserved, as they represent the history of the processes used in the limit determination. The diagrams will be useful during the production of the mechanism, particularly so at first. Questions of change in model, tolerance changes, improved methods, etc., can be intelligently decided in a short time with their aid. The analysis diagrams with their recorded information will be useful in avoiding duplication of effort and in securing continuity of plan during production, when the designer may be engaged elsewhere. The diagrams, properly made, demonstrate that the respective limits will produce the desired results of function and interchangeability. *Faith in the limits* is necessary for factory morale during production.

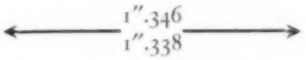
COMPONENT drawings should be on a scale sufficiently large to permit clear delineation of all surfaces and intersections and to furnish ample space for the dimensions. Basic dimensions, clearly distinguished as such, should be entered without limits. The chosen locating points should be shown clearly. During the limit analysis the various surfaces have been divided into their proper machining operations. From the analysis diagrams the adopted limit dimensions necessary to control each operation should be transferred to the component drawing. Resultant limits should *not* appear on the component drawing.

The contour to be formed by each operation should be so dimensioned as to provide complete information as to the shape of the cutting tool. The positions of the essential points in this contour are given direct to the working points and independent of any other surface. Rare exceptions may be made if a close special relationship is desired between two surfaces formed by separate operations. In this case the standard fixture holding the component is moved on an auxiliary slide to bring one of these surfaces in contact with a fixed stop on the machine platen, while machining the other surface. Another exception may be in case of a relatively unimportant surface permitting wide limits, for example the "run-out" of a mill cut resulting from stopping the cutter in the component. The latter exception permits the use of a very simple gage from the end of cut to the nearest definite "landmark" and should be so specified on the drawing.

Component drawings should carry all the essential dimensions for the cutting tool and for the gages required to control each operation. Each limit dimension is to be interpreted later by a gage of some form. Unnecessary dimensions are to be strictly avoided. The positions of the dimensions should indicate how the component is to be located in fixture and gage, and should designate the portions of the surfaces to be gaged for the control of each operation. Routine gages which explore the total area of surface formed by an operation are expensive. Seldom will these be required.

In the detailed final design of actual fixture and gages for each operation, departure should not be permitted from the drawing specifications. During progress of equipment design, or later, if a valid reason for a different method appears in a given operation, such change should be reconciled throughout the limit analysis and diagrams, and incorporated in the component drawing. The limit analysis diagrams should correspond in every detail to the methods specified by the component drawings. And these should all correspond with the fixturing and gaging.

In manufacturing the mechanism discussed the component drawings are not used by the production department. All dimensions are interpreted in the machining and inspection departments by gages. The gages are set and checked by reference blocks. During the limit analysis the actual dimensions of both maximum and minimum are necessarily used in computation and are so expressed on the analysis diagrams. The component drawings specify directly the maximum and minimum dimensions for the reference blocks used to inspect the working gages. On the component drawings, therefore, all dimensions other than basic should be expressed by the actual figures for maximum and minimum, thus:



The service of developing production design, and of equipment design corresponding thereto, might be supplied advantageously by concerns whose business is now that of building gages and special tools. Continuous engagement would permit the building up of an able and progressive engineering corps in this highly specialized field. The effect of a few such organizations would soon become apparent and would do much to increase our industrial efficiency. This would render us better able to compete with reviving foreign industry and its cheaper labor. Nowhere would it aid more than in our national defense.

In spite of our competent methods of machining and gaging, the neck of the production bottle still lies in deficient production design. The best plans of organization for mass production may either be emasculated or made effective by the degree of excellence entering into the design of the matériel required. Nor is there any substitute for an early start. When war involves us the immediate availability of precise specifications for ordnance may well be the deciding factor.

In Defense of Chaplains

Plain Philosophy of a Practical Pacifist

By Col. Alva J. Brasted*

A CONSIDERABLE sentiment is being developed in this country which is bitterly antagonistic toward any kind of armed forces for national defense. There are more than a few preachers who are not only advocating unpreparedness from the pulpit, but say that rather than to participate in a war for any cause they will go to jail! There are some people in this country today who are saying that "no candidate for ordination to the ministry of the Christian Church who professes a willingness to sanction war" (regardless of the cause) "or to participate in it should be accepted as a minister of the Prince of Peace." They are saying that a chaplain who becomes a part of the military forces is a notorious sinner, on the level with wife beaters, saloon keepers, adulterers and murderers.

It does not behoove me, neither have I the desire to take cognizance of those who assail in a slanderous manner the chaplains of our naval and military services. Nobody can make me angry by calling me names. With Paul I know that I am chief among sinners. My policy in dealing with these people who are thus assailing us is to turn the other cheek also. As Spurgeon says: "The best way to answer slander is to live above it."

Christ respected government as an institution necessary to civilization and knew as we do that physical force is absolutely necessary to government. He honored a soldier more than he ever honored anyone else, and certainly realized that governments in dealing with lawless men and nations must at times use agencies such as would be entirely unnecessary in the Kingdom of God. Christ never condemned governments for using force when used to promote the cause of righteousness.

I recall an instance in President Lincoln's administration, as told by a biographer. It had to do with Lincoln's attitude toward spiritual direction, and may be summed up in a few words spoken when a delegation of Chicago ministers came to him urging him in God's name to free the slaves without further delay. His reply was that when the Almighty wanted him to free the slaves He would deal directly with Lincoln himself instead of indirectly through Chicago. Now, I believe that God speaks to you and to me, that when He has a message for us in Washington I think it will come directly from Him to us and not by way of Dayton or Chicago.

Let us all be real Christian pacifists and use the weapon of non-resistance, and non-resistance is a powerful weapon. Every good parent uses it. If the father of the Prodigal in the parable had not used it the son who left home in all probability never would have returned. Every efficient teacher uses this weapon of non-resistance, using at times a look or word of admonition rather than the rod. The good priest used it in dealing with the thief, Jean Val Jean, causing the offender to repent and to walk in the way of Christ. Jesus used this weapon of non-resistance in the Garden and at Calvary. He might have called more than twelve legions of angels but He did not. He said: "Thinkest thou that I can not now pray to my Father and He shall presently give me more than twelve legions of angels?" (Mat. 26:33). A legion in Christ's time meant an armed force of from three to six thousand men, and might have meant an entire army. Christ did not call these legions, but the point I wish to make is that in the Divine order of things these legions were in readiness.

IT is the Christian way to return good for evil, but returning good for evil does not always mean that the weapon of non-resistance shall be used. There are times when it is Christian to use force. "Spare the rod, spoil the child." Christ in the Temple resisted by using not only spiritual force but by using physical force in overturning the tables of the money changers, and He used a physical weapon emblematic of authority, and one that He apparently was ready to use as effectively as a strong arm and strong determination could use it. Jesus said: "Render unto Caesar the things that are Caesar's and to God the things that are God's." In other words the Saviour here recognized the fact that among men there must be the material government as well as the spiritual, and that men owe allegiance to both. Christ approved of government. He obeyed the laws, and by both deed and word placed His approval upon the government. We know that he could not have approved of everything that the Roman Government did, but certainly He realized that the poorest government is better than anarchy.

I need not quote from the Scriptures to remind all that orderliness and obedience are required by the Christian. Christ obeyed the laws and Paul obeyed the laws, and both Christ and Paul approved of government.

Now, Christ could not have approved of government and at the same time condemned the armed forces that make government possible and effective. Our own government was established by military force. The national governments that have blessed the world most have been established by military force and have been maintained by military force. Yes, the adequate military force has been, was in Christ's time, and still is essential to the establishment and preservation of efficient government; and one can not consistently approve of government and condemn as notorious criminals the armed forces that are essential to its establishment and preservation.

Our Saviour said: "I come not to send peace but a sword," and again He said: "He that hath no sword let him sell his coat and buy one." Certainly, whatever the meaning here, this is not the language of one who condemns the armed forces, the defenders of country, as mass murderers. Christ honored a soldier more than he ever honored any one else when He said to the Centurion: "I have not found so great faith—no not in all Israel."

Paul was the great exponent of Christianity, and he honored the military service by making his letters replete with military figures of speech, and on one occasion when his life was threatened he called upon the Roman Captain for help; and this Roman Captain with horsemen, footmen, and spearmen escorted him safely to Cesarea, and thus enabled him to carry the gospel to Rome also. If there had been no place in the Christian category for armed forces for defense, certainly Paul

*Chief of Chaplains, U. S. Army.

would not have been so illogical, inconsistent and unchristian as to call upon them for protection.

Justice can not always be attained by non-resistance. If all peoples were dominated by Christian moral standards there would be no purpose in having armed forces for the enforcement of the law or for community and national defense. It is still true that with millions of persons and many local and national governing bodies Christian moral standards mean little or nothing. And the only way to thwart some individuals and some nations in the accomplishment of their unjust purposes is the interposition of armed forces, too powerful for them to defeat. The day of the policeman and the soldier has not passed.

IN this country we have a police force of about 120,000 armed men. And in addition to this force there are thousands of sheriffs, armed guards, and watchmen, constables and secret service men, etc. These policemen are trained marksmen. Like soldiers they go on the range for pistol and machine-gun practice. They are trained to use clubs, guns, hand grenades and gas. Policemen are often called out in large numbers to battle gangsters and other outlaws. They are on the job day and night, and frequently they are compelled to take human life.

The need of armed forces to safeguard property and life in this country is illustrated daily in every city. We have not forgotten what happened in Boston when Calvin Coolidge was Governor of Massachusetts and the Boston police, most of them, went on a strike. Riot and general lawlessness followed, and order and safety were not restored until the National Guard was called to duty. So far as I know, there is no objection even on the part of ultra-pacifists to a police force. But policemen are armed, skilled in the use of weapons of death, and stand ready to combat the individual or the mass and to take human life if necessary in the performance of their duties.

The country needs an army just as certainly as it needs a police force, and the army is needed in time of peace as well as in time of war. If space permitted I would speak of some of the peace time services of our Army. If it's a sin to have an army it's a sin to have a police force. Just how anybody can justify the use of force in the defense of a city and not justify it in the defense of country is beyond my powers of understanding.

I don't think that the following statement needs much clarification. In the last analysis, when diplomacy and all else fails the strength of any government to survive is the efficiency of the organized armed forces in maintaining it. Is it right or wrong to use force, right or wrong to use armed forces in the defense of the country? We will for arguments sake take the position that it is wrong. What then? If to use armed forces in the enforcement of law and defense of a country is wrong, then should gangsters come we will let them take what they want. Should you see a housebreaker coming through your window you will not use a gun but let him take your watch and money and jewels without attempting to stop him. If it is dangerous to go to a foreign country you will not go there. If an enemy destroys our ships at sea we will not attack him or fire a gun in self defense, but rather reprimand the shippers and tell them to keep their ships off the ocean. If the people of another country murder our nationals we will say: "Serves them right; they should have stayed at home." If foreigners object to our immigration laws and come over here from Asia and Africa and everywhere by the millions we will let them come, for the only way to stop them is by force, and of course we can't use force. If any people wish to shoot across our borders and kill our little boys and girls, and men and women, we will solve the problem by telling our people not to live so near the border and to keep away from those bad people. We will not use guns but rather put up signs, in pink letters, all along the boundry line: "Please keep off American grass" and "Please don't shoot across the border."

IS war sin? To those who believe that a people should sacrifice all for the sake of peace, who believe in peace at any price, it is sin to participate in war regardless of the cause. To them Joshua and Caleb sinned when they plead with the people to go up and possess the land, and Joshua and Moses and Aaron sinned at Reph'i'dim, where Joshua commanded the army of Israel and Moses prayed, and Aaron stayed Moses' hands. To them Israel sinned when she accepted the leadership of General Joshua and the aid of his military forces in possessing the promised land. To them the angel of the Lord sinned when he smote the army of Sennacherib, thus saving Israel from the hands of the Assyrians. To them David sinned when by the aid of armed forces, and under the direction of Jehovah he established Israel as a world power. To them Charles Martel sinned when by force of arms he stayed the progress of Islam and saved Europe from domination by Mohamet. To them the liberty loving people of England sinned when on June 19, 1215, by force of arms they gained for the people the Magna Carta, that great charter of English liberties. To them Patrick Henry sinned when he spoke the immortal words: "Give me liberty or give me death," and to them Washington sinned when he accepted the leadership of the colonial armies. To them every dollar spent to maintain our military establishment is a tainted dollar, every battleship and every fortification, and every military organization is the work of the devil, and every chaplain in the naval and military services is in league with the arch enemy of man, for we are all accomplices in the crime of mass murder.

I am not attempting to justify those who take the sword without just cause, those who take the sword to seek revenge and spoils. They that take the sword for selfish and criminal purposes shall finally meet overwhelming opposition and shall perish by the sword; but those who justly defend their homes and country against the Sennecaribs of earth, stand in the place of that angel who defended and saved Israel from the Assyrians.

I SAY that it is the duty of the citizen and the Christian to provide adequately for the common defense, the defense of home, community and nation, and that he who fails to so provide is guilty of the sin of omission. Yes, and if he attempts to break down the nation's defense of home and country he is guilty also of the sin of commission. I say it is sin not to provide adequately for the defense of home and country. It is the duty of the head of every household to provide for the defense of his home. Let us not forget that the adequate defense of country is even more important than the defense of town or city.

Not long ago a man in Washington said, "What matters it under what flag we live? Why have an Army and a Navy? Why have any national defenses? If an aggressor nation insists on taking over America, rather than to have war why

not let that nation take what she wants? Does it matter under what flag we live?" I am not yet ready to trade the Stars and Stripes for any other flag in the world, not even the flag of Japan, China, Russia, Mexico, Italy or Germany. The liberties that we enjoy have come to us at a cost of supreme sacrifice. I fear that many do not appreciate them. They must be preserved.

But, says one, there is no danger. We don't need arms of defense. Who ever dreamed in 1915, twenty years ago, that in less than a decade Russia would have a government such as she has today? Who ever dreamed eighteen years ago that 1935 would find Europe with armed forces exceeding by many millions those of 1913 and 1914? Who ever dreamed that many nations nominally Christian, would renounce their solemn obligation to pay America the debts they owe her?

There is as much difference between the militarist and the man who believes in safe and sane preparedness as there is between the highway robber and the law abiding citizen, who, having made his own house secure, says his prayers and goes to sleep. We have fire drills but we don't start fires. We teach first aid but we don't break bones and throw people into rivers. We have fire drills and teach first aid so that in case of an emergency we will be able to act quickly, wisely and effectively, and that is why we have an army and a navy. We believe in preparedness against war not because we want war but because we want to prevent war. Having a good watch dog and locking the door, and having a loaded gun near your pillow are certainly safeguards against robbery, and being prepared helps to keep us out of war. We build dykes because we don't want floods. We have fire departments because we don't want fires and we have armed forces because we don't want war. We want to be strong enough to stop a war before it gets started. The world is not yet out of the jungle. When the world gets out of the jungle we can dispense with our armed forces. We must face conditions not as we would like to have them but as they are. He who is prepared for a conflict stands a better chance of victory, and of coming out of the conflict with little injury than he who is not prepared. If we had been prepared in 1917 thousands of heroic lives would have been saved. America means too much to us who love her, means too much to the world, to suffer her to be defenseless. We shall not permit America to be trapped.

No sane person wants war any more than he wants disease or flood. War is not Christ's way, neither is it Christ's way to suffer the aggressor to usurp the rights of the law abiding and peaceful and substitute ruthless tyranny for justice. He who takes the sword as a bandit and aggressor sins. He who takes the sword in the defense of the right against the bandit and aggressor who would rob and murder, may be acting in accordance with the will of God, and if he fails to the best of his ability to protect his charge he is not a faithful steward, but a slacker and coward. In the blood of a man God has placed white corpuscles, soldiers of the circulatory system. When enemy germs, dangerous, destructive germs enter the blood and menace life, these white corpuscles rush to the affected part and combat these enemy germs. If the germs of tuberculosis attack a lung, these white soldiers begin at once to imprison the enemy germs by building a wall about them. The enemy germs are the predatory forces of avarice and greed, they are the criminal men and criminal nations who disregard the spiritual appeal of kindness and love, and heed only the language of force. The white soldiers of the blood are both the spiritual forces of non-resistance and the strong right arm of might, our armed men of the police force and army and navy, that stand ready to act in a righteous cause when kindness, reason and love fail. When the enemy germs have disappeared the white soldiers of the blood will not be needed to combat them. When Christ reigns and rules the minds and hearts of men and governments, the day of the armed policeman and criminal courts and the soldier and sailor will have passed.

AMERICA has military forces only for purposes of defense. And this is our sole and only basis for their existence. The Constitution of the United States and our governmental policies of the past and of today contemplate no other reason than adequate national defense as the justification for our national military forces. I am willing to sacrifice everything, *but that which we have no right to sacrifice,* for the cause of world peace. I believe that we have a country that is worth defending, that the priceless liberties that have been passed on to us, at the cost of supreme sacrifice, must be preserved.

What classification shall we give the man who refuses to provide for and protect his own? What shall we say of the groom who will not promise to protect his bride, and what shall we say of the citizen who refuses to take oath that he will protect the flag of his country?

We of the military service believe in war only as a last resort. As horrible as war is we believe there are some conditions that are worse than war. We believe that there are some things that are dearer than life. We do not believe in the teaching of "Peace at any price." "Peace at any price" seems to me to be the attitude of one who is willing to sell his birthright for a mess of pottage. There are some possessions that men of principle and courage will not surrender, even though to defend them may mean the horrors of the battlefield.

Robert E. Speer, one of the greatest missionary leaders of this century, in his book, "The Marks of a Man," says "Our contemptible theory is that a man must live. The devil held that a man would sacrifice anything for the sake of his life; and the world at times seems to have gone over to the devil's theory as ethically correct. Men do not need to live. A moral code which rests upon this idea for its foundation is rotten, and to surrender the truth which is divine and eternal for the sake of a life, our own or another's, is to choose the devil instead of God and to pollute the springs of the life that is saved at such a cost." Better a righteous war than an unrighteous peace!

As good citizens and good Christians we must do all within our power to advance the cause of world peace. Many are the schemes to promote it. But finally, I am convinced that the only absolute cure for war and the only hope of the world lies in the mastery of Jesus Christ. Laws, treaties and agreements are so often the garments of hypocrisy. Treaties mean little or nothing unless the heart of a people is right, unless there is the character to keep them faithfully.

In the last analysis the actions of individuals and nations are no better and no worse than the inner imperative—no better and no worse than the character—out of which are the issues of life. The causes of war will exist until hearts are right, hence the responsibility of all good citizens to build and help others build the house of character under the supervision of the Master Architect. Hence, the responsibility to extend throughout the world the Kingdom of Him Who is love incarnate, and Who is the Way, the Truth and the Life.

ARMY ORDNANCE

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Month by Month

THE news that Ordnance Day—the annual meeting of the Army Ordnance Association—is to be resumed this year at the Aberdeen Proving Ground will be welcomed by all readers of this Journal. As announced in general terms elsewhere in this issue, Ordnance Day will be held, with the approval of the Secretary of War, at Aberdeen, on Thursday, October 3, 1935. At this writing detailed plans are being made of which due announcement will be made to members individually and in these columns.

BACK TO ABERDEEN!

After an interval of three years Ordnance Day will be held under unusually auspicious circumstances. It will mark, after a fashion, the dedication of the new Aberdeen. Since last we gathered in 1931 to witness the program of current tests and firings on the shores of the Chesapeake the reservation itself has undergone quite a transformation. Many of the old installations have been replaced by structures of more permanent and beautiful design, technical facilities have been improved and all the features as befits a premier scientific establishment have been refurbished. (Although written in the past tense many of the improvements are still under way and most of them are scheduled for completion before fall.) The return of the Ordnance cohorts to Aberdeen in October thus will have the aspects of a homecoming.

Moreover the lapse of three years since the last assembly has witnessed a transformation as well in some of the principal items of military equipment with which American industry should be acquainted. In 1931 mechanization and modernization were precepts of military doctrine observed more in theory than in practice. The days were trying ones for private as well as public pursestrings. Since then both types have eased off generally. It was because both, and especially the former, were so restricted that the meeting itself was discontinued for the time being. The intervening years have brought definite programs for translating the philosophy of mechanization into practice. Modernization has advanced to the point where few of the old relics of 1918, which by courtesy were given the title "Army trucks," are in existence. With mechanization as applied to automotive, field and antiaircraft designs the speed of accomplishment is naturally slower. Nevertheless there have been improvements in technique and application which, if anything, are more noticeable than during any preceding period. After years of study, trial and error, we are beginning to crystallize engineering opinion and to perfect devices with the required mechanical qualities.

Hence it is particularly fitting that for this homecoming the American Society of Mechanical Engineers has been invited to participate. The A. S. M. E. more than any other professional group in our midst represents the power and force of our combined engineering talents upon which ordnance production in time of war rests. As in the earliest days when the Aberdeen gathering was begun seventeen years ago, the alliance with and reliance upon the mechanical engineer for war-time proficiency is still basic.

The Aldershot Tattoo is a military institution ranking the other traditions of empire in the British Isles. Some might be tempted to compare our Ordnance Day with this venerable pageant. "The Aberdeen Tattoo" might yet be an eventuality. But at this stage it remains what it was originally intended to be, a gathering of our military and civilian engineers and our industrialists to witness a program of current firings and tests of military equipment. Ordnance Day has nothing to do with the glorification of war; it represents a definite expression of preparedness *against* war. It remains in 1935 as it began in 1919, a technical and scientific demonstration of military requirements for the advancement of a great responsibility of the common defense.

A PILLAR of strength in the Ordnance cause in the United States was removed from our midst by the death, on June 1, 1935, of Mr. John C. Jones of Philadelphia. His many friends with whom he had been associated most intimately for so many years in this important work are deprived of the association of a gentleman of the very highest caliber. Chief of the Philadelphia Ordnance District in war and peace, former president of our Philadelphia Post and at the time of his death a director of our National Association and chairman of the Philadelphia Ordnance District Advisory Board, Mr. Jones was truly a public servant and citizen whose death leaves vacant a personal and official place in ordnance affairs.

JOHN C. JONES

For his brilliant war-time service as chief of the Philadelphia Ordnance District Mr. Jones was awarded the Distinguished Service Medal. This honor represented in some measure the almost superhuman task he accomplished in that great emergency. Early in 1918 he was given the difficult assignment of mobilizing the industries of Philadelphia for the production of ordnance equipment. Bringing to the undertaking a vast commercial and industrial experience he was able to coordinate the industrial power of the country's third largest industrial area and to harness it for the then great task of meeting its share of our military program. Under his jurisdiction were many of the largest explosives, ammunition and rifle factories of the country. Subsequently he became head of the Philadelphia District Ordnance Claims Board bringing to that difficult work the same zeal, fairness and enterprise in the process of demobilization which he had exerted toward

building it up. Until 1933 he carried on the peace-time duties as head of the Philadelphia District and when he retired he became the chairman of the district's Advisory Board.

Mr. Jones was born in New York City. He attended Taughannock Hall on Lake Cayuga and Pennsylvania Military College. At the latter institution he received degrees in engineering and military science. He entered the employ of the Harrison Safety Boiler Works after graduation and later became its president, an office which he filled for many years. His interest in Pennsylvania Military College continued throughout his life having served as a trustee of that institution for many years.

When the seventeenth anniversary of the Philadelphia Ordnance District was observed under the auspices of the Philadelphia Post of the Association and the Chamber of Commerce on March 26, 1935, Mr. Jones was singled out for honors which were well merited. On behalf of industry of Philadelphia he was presented a plaque by the president of the Chamber of Commerce, and the Ordnance Department of the Army honored him with a testimonial scroll of thanks. The scroll, presented by Maj. Gen. William H. Tschappat, Chief of Ordnance, contained this expression which undoubtedly sums up the career of this public-spirited gentleman: "His tenure of office, begun during the World War and continued for many years thereafter, was marked by high leadership, unselfish purpose and eminent success in the interest of the United States." For public epitaph of our former associate no more fitting sentiment could be expressed. And the mere expression of it under such auspices, we are confident, was ample reward to one whose only purpose was to serve his fellow citizens to the best of his talents and in that service to attest his loyalty and zeal for the national defense of his country.

The G. H. Q. Air Force

WHILE the newly formed G. H. Q. Air Force of the United States Army is a topic of major military significance it also has a note of personal interest for members of the Army Ordnance Association. Maj. R. L. Maxwell, Ord. Dept., has recently been assigned to the important office of Ordnance Officer of the organization. As secretary of the A. O. A. and editor of this journal and more recently as executive officer of the Philadelphia Ordnance District, Major Maxwell has given many evidences of his enterprise and ability.

The G. H. Q. Air Force itself has been described by the War Department as "the most important and evolutionary step toward modernization of the forces of the United States that has been taken since the World War." It is a pioneer undertaking. The commander of the force reporting directly to the Chief of Staff gives the Army a highly mobile organization of great potency. Its field will be the development of tactics and strategy of air warfare. Its supply problem will not be limited to that of the aircraft involved but the items of ordnance with which it is armed and the maintenance of this equipment will present problems of the first magnitude. All this is indicated by the very nature of the new organization, the principles of which "are transcendental in their full implications and will doubtless influence the development of other arms as well as of the Air Corps." Students of our national defense have already placed their hearty approbation upon the principles governing the new organization and they will watch its development with sympathetic understanding. Their expectation of what it will produce in the way of effect on all military organizations will probably be surpassed by realization.

It is unfortunate that this new tactical arm should, almost at its very inception, have misunderstandings placed in its way. The recent political fiasco by which secret and confidential war plans governing our military operations were publicized and misunderstood is a cause for grave concern. In administering a rebuke to the chairman of the Military Affairs Committee of the House of Representatives the President of the United States did well. However the effect on the untutored mind which stands aghast at the mere thought of war plans of any kind is doubly pathetic. We wonder what some editorial writers of the United States consider to be the real nature of secret and confidential war plans! They apparently believe that professional Army Officers have no responsibility for studying possible situations involving the national defense. Whatever their belief, such writers are quite dense when they voice biting criticism of strategic location of our military stations. Anti-Army minded, they delight in every flimsy fact which, when tested, can be used to sustain a misinterpretation. Any confidential discussion in war planning of the location of an air base near the Canadian border has no significance whatever as to the relations between Canada and the United States. First, such a location as a defense measure does not necessarily imply or even expect that we might ever be at odds with Canada. We might be at odds with someone who would be audacious enough to approach the United States through Canada. It is such an eventuality the professional soldier engaged in war planning must face. At the same time he can share, as he undoubtedly does, the hope that the long enduring peaceful relations between the two countries will never have a shadow cast upon them.

Once again critics are imputing to things motives which do not exist. The unbroken peace with Canada has not been affected by any installations of peace-time significance on either side the international line. Representative Plumley of Vermont, in the words of the *Army and Navy Journal*, performed a service to his country and to Canada when he pointed out that "the Dominion has as little reason to be alarmed over our proposal to establish an intermediate transcontinental base near Chicago as we to have the jitters over the existence of six Canadian air bases on the border. Canadian planes easily could bomb numerous American cities provided they willed to do so and were not intercepted. Within half an hour such planes could reach Buffalo, within three or four hours, New York, Cleveland, Chicago, etc. Vancouver is only 25 miles from American soil with our navy yard at Bremerton and the great city of Seattle a few miles beyond. We have had an air station at Selfridge Field, Mich., for years, and Canada has given no thought to the possibility of its use against her; and the proposed intermediate base, as Mr. Plumley said, would be 250 miles from the Canadian Border and 475 miles from the nearest big city, Toronto. Thus, the whole business, as the Vermont Congressman observed, is 'much ado about nothing.' He further pointed out the accepted fact that 'we would think Canada a poor neighbor unless she had national defense machinery, which could, in the event of difficulties with a common enemy, be used to our common advantage.' There is sense in this Plumley view and it will be recognized by all thinking people on both sides of the line."

Carts Before Horses

An Editorial

OUR day and generation will be remembered in the annals of peace and war for many things—some of them sound in theory and beneficial in practice, others of them silly in thought and application. Ours seems to be a day characterized by slipshod conclusions. Many of our leaders of public opinion on questions relating to the national defense become lost in a fog of crazy notions, they confuse effect for cause, they misapprehend the particular for the general—in a word, they put carts before horses.

Proponents of the national defense of the United States through industrial preparedness are not unacquainted with these types of reasoning. In recent years the whole subject of armament has been misrepresented and misinterpreted in just such light. We have become accustomed to this sort of reasoning from some political platforms and some pulpits. But we are a bit surprised when we find it advanced by those who hold high place in the councils of international law.

Dr. James Brown Scott, president of the American Society for International Law, delivered an address entitled "The Neutrality of the Good Neighbor" before the Twenty-ninth Annual Meeting of the Society in Washington, D. C., on April 25, 1935. He is well known as a lecturer and writer in his chosen field. He is also secretary of the Carnegie Endowment for International Peace. All right-thinking people share his love for peace although many will differ from him as to effective methods of guaranteeing it. The eminent doctor seems to us to have departed from the high plane of sound reasoning when in the above address he advocated Government monopoly of the manufacture of armament. It looks as though he has entered the ranks of those who put carts before horses in their process of reasoning.

THE speaker took as his thesis the prevention of private manufacture of armament. He based his view on the following doctrines from the Emperor Justinian which were issued nearly fourteen centuries ago. In the Constitutions of Justinian "Title XIV Concerning Arms," the following laws are written:

"Chapter I. . . . desiring to prevent men from killing each other, we have thought it proper to decree that no private person shall engage in the manufacture of weapons, and that only those shall be authorized to do so who are employed in the public arsenals, or are called 'armorers'; and also that manufacturers of arms should not sell them to any private individual. . . .

"Chapter III. Therefore, God directing our thoughts, we decree by the present law that no private individual, or anyone else whosoever shall, in any province or city of our Empire, have the right to make or sell arms, or deal in them in any way, but only such as are authorized to manufacture them can do so, and deposit them in our armory. . . .

"Chapter IV. But in order that what has been forbidden by us to private persons and all others may become clear, we have taken pains to enumerate in this law the different kinds of weapons whose manufacture is forbidden. Therefore, we prohibit private individuals from either making or buying bows, arrows, double-edged swords, ordinary swords, weapons usually called hunting knives, those styled 'zabes,' breastplates, javelins, lances, and spears of every shape whatever, arms called by the Isaurians 'monocopia,' others called 'sitinnes,' or missiles, shields, and helmets; for we do not permit anything of this kind to be manufactured except by those who are appointed for that purpose in our arsenals, and only small knives which no one uses in fighting shall be allowed to be made and sold by private persons."

"Here we have," observed the speaker, "a clean-cut statement of a complete governmental control of the manufacture of arms and munitions, the only exception being what we would today call, I opine, 'penknives' for the sharpening of pencils or the removing of blots from a manuscript."

From this basis the speaker then proceeded, after a none too exhaustive review of history, to the following:

"What, then, should be the policy of the United States as an enlightened nation? Assuredly the Government of the United States should not make itself a party to wars in fact if not in form, as it does by permitting its citizens and residents to manufacture and to export commodities, the sole or indirect purpose of which is the destruction of the lives of persons who are not in the slightest degree our enemies. Nor should it become an actual party to the war for the mere protection of such commerce. If war we are to have, it should be strictly in self-defense, not in defense of commerce with belligerents, whether that commerce be in arms or ammunition, or in hitherto peaceful commodities such as we now know are useful for the continuance of warfare." (We interrupt to ask: What isn't useful for the continuance of warfare?)

"Now, in case of a war of self-defense, the Government of the United States would be in need of arms and ammunition. It should be in a position to supply that need itself so as to meet effectively any aggression which menaced its existence. If it be said that the manufacture of munitions and of other commodities usable in war is a private undertaking, and has been so treated in times past, an answer is that the Government of the United States has taken charge of the Postal Service of the United States, which was also in times past a private enterprise. If it be maintained that the exclusive government manufacture of arms and ammunition would be more expensive than manufacture by commercial firms, it may be said that the arms and ammunition manufactured by the United States would not be supplied to belligerents, because no neutral government as such can, even under the existing law of nations, lawfully supply belligerents with such commodities, and there would consequently be no question of meeting the competition of private industry in other lands."

IT is not our purpose in these editorial remarks to invade the field of international law—that we leave to trained practical international jurists. From the historical ordnance viewpoint it may be within our province to question Doctor Scott's reasoning because it impresses us as being very faulty. The mere fact that even so great a man as Justinian, fourteen centuries ago, promulgated these regulations is not of itself proof positive that they were either correct or expedient. Indeed they were neither! Lifting these regulations from Justinian's Constitutions gives them merit so far as present day application is concerned only if they were productive of

maintaining peace and sustaining the existence of the Roman Empire. Again, they were neither! To propose them as Doctor Scott does as being desirable policy for the United States today is the unrealistic and unwarranted kind of procedure that is misleading so many of our people. It is a good case of the cart before the horse.

Justinian, no doubt when he approved this law prohibiting the private manufacture of arms, was conscientiously seeking to stop war once and for all and to save the then declining Roman Empire. He had already experienced a period of the bloodiest and costliest wars. *During his reign the three great wars in which he engaged decreased the population by one hundred million.* After such harrowing experience it was quite natural that he should grasp at any method which would seem to prevent conflict. And so he wrote into the law the prohibition against the private manufacture of arms. Did it prevent future warfare? Not at all. And worse still it sounded the death knell of the great Roman Empire which was shortly thereafter torn to shreds being unable to meet the onslaughts of the vandals who swooped down upon it. It may be mere speculation to inquire to what extent this policy of government monopoly was responsible for the outcome. Experience seems to indicate, anyway, that when a nation takes to itself the exclusive production of weapons of defense it is not long before it begins to disintegrate. Certainly the Roman Empire under Justinian is a good case in point and we are surprised that so eminent a scholar as Doctor Scott should raise it and apparently advise the same practice as national policy for the United States.

Justinian himself stands out as a codifier of the law rather than a great legislator. He was not successful as a wager of war inasmuch as he carried on unending conflict with the Persians with mixed success. He was not much concerned with international peace except as he could sustain it by the sword. At home the Nika Revolution in 532 turned out to be a very dangerous revolt which had to be put down with severe measures and gave rise to a form of absolutism no better expressed than in those sections of Justinian's law which Doctor Scott has cited. Nationalization of the arms industry—and the history of Justinian seems to prove it conclusively—hangs on the horns of this perilous dilemma: if aimed at the suppression of revolt it simultaneously strengthens a foreign enemy, if aimed at a foreign enemy it simultaneously weakens national effectiveness. By his law Justinian quieted the Nika Revolution because the revolutionaries were deprived of their arms. It might have been better for Justinian to have fought the revolution and later to save the empire. As it was he "cracked down" by weakening the power of the empire and finally losing it altogether.

HERE we have a case of the cart before the horse as advanced in the current discussion of methods for the prevention of war. Doctor Scott's thesis impresses us as being on a par with the other defective schemes which so-called opponents of war are advancing today. His address containing the Justinian reference has been widely publicized. No doubt it may be accepted in its entirety as sound and desirable policy. For some it will matter little whether historical considerations stand the light of analysis. Therein lies the damage of this sort of strange reasoning—a severe handicap for a peaceful people who are anxiously striving to limit war.

We say nothing of the situation existing in this country today where the trained professional student of national defense is frequently prohibited from expressing his trained viewpoint. When an admiral of the Navy undertakes to publish an article, as in the recent case of Admiral Yates Sterling, in which he commented upon international relationships he was accused by some of our pacifist groups as talking out of turn, it looks as though the only people in our midst who consider themselves qualified to talk on the subject are those who put carts before horses. While this situation continues we may expect many of the mistakes of history, including that of Justinian, to be set up as desirable national practice. We need not go back fourteen centuries to find the error of government monopoly of the arms industry. We had it before our eyes here in the United States just seventeen years ago. What Justinian proposed and what happened under his proposal is really of little moment. It is far more important and more vital that we capitalize our own recent experiences. This we have done under our present National Defense Act which looks to American industry to produce the sinews of war in emergency. It would be more to the point—and the horse would be before the cart—if those who attack our present national defense system were to do it in the light of factual experience with a view not to the defeat and ultimate passing away of the United States but to its preservation, peacefully and permanently.

JUSTINIAN'S theory proved itself to be the worst sort of policy and we believe Doctor Scott's would too, particularly when he cites the Postal Service of the United States as a case in point. Where does the distinction lie between governmental and non-governmental ownership and operation? Surely it is but a step from the Postal Service to government ownership of other means of communication—to transportation, next to public utilities, then to banking, mineral resources, manufacture and all forms of enterprise and service, the production of armament in time of peace and war included. This is, of course, contrary to the traditional American system of government if that means anything any more. There is a telling instance before our eyes today of a government operated along these communal lines. Spread across a great portion of the continents of Europe and Asia is a gigantic power that has scrapped private enterprise and has government manufacture and monopoly of all commodities. Yet that system carries with it today the largest armed force on the face of the earth. Doctor Scott of all men in our midst today, who served as chairman of the State, War and Navy Neutrality Board from August, 1914, to April, 1917, should know from real experience that the problem of modern armament in major war requires the full industrial and manufacturing power of the entire country.

Our people will demand that our doctrinaires be realistic in their proposals for limiting war. Time is the most expensive item in all modern warfare, money cost is secondary, efficiency is mandatory but in no case can our plans for modern war be based upon a change of our economic system. Justinian and Doctor Scott to the contrary notwithstanding, the American way to prevent war and to preserve a free people is to do it in accordance with our traditional policies of coöperative effort with undue advantage for none of us and equality of responsibility for all. This can, and will, be done—we hope—by following true and tried principles under which carts will follow horses in always clear, logical and fair order.

Association Affairs

PHILADELPHIA POST

MR. PHILIP GADSDEN, Chief of the Philadelphia Ordnance District, was re-elected President and Mr. George W. Elliott, General Secretary of the Chamber of Commerce of Philadelphia, was elected to the Vice-Presidency of the Philadelphia Post, A. O. A., at the annual meeting held on May 13. Also elected as new members of the directorate of the post were Mr. C. L. Jordan of N. W. Ayer & Son, Lieut. Col. John Q. MacDonald and Major K. K. V. Casey, of E. I. duPont de Nemours & Company. The annual meeting came as a fitting climax to the program of activities of the Philadelphia Post during the past year, the highlight of which was the mammoth meeting held on March 26th at which the Secretary of War, Hon. George W. Dern, was the honor guest. The new officials of the post were active in the arrangements for the Secretary's visit. The National Association shares in the good fortune of the post in having these gentlemen identified with its management.

At the annual meeting Maj. R. L. Maxwell, some time Editor of this Journal and former Secretary of the Army Ordnance Association, bade farewell to the group. During the past year he served as secretary of the Philadelphia Post and under his guidance the organization established many new records. Major Maxwell has been ordered to Langley Field, Va., where he will assume the unusually important duties as Ordnance Officer of the recently organized General Headquarters Air Force. He brings to this assignment a lengthy experience in the technical and tactical phases of ordnance application. A testimonial dinner was given him by members of the Philadelphia Post prior to his official relinquishment of his duties at which his many friends recorded their personal regard and esteem.

At the meeting of the post all other officers were re-elected. In addition to Mr. Gadsden they are: John P. Sykes, E. T. Longstreth and J. L. Poultney, directors. Maj. W. C. Hamilton succeeds Major Maxwell as secretary-treasurer of the post.

MILWAUKEE POST

THE famous German long range guns which bombarded Paris from March 23 to August 9, 1918, from locations 100 kilometers away, was the subject of an address by Col. Henry W. Miller before a meeting of the Milwaukee Post of the Association on May 7, 1935. The speaker, who is a member of the faculty of the Department of Mechanism and Engineering Drawing of the University of Michigan, is well known as an authority on this subject. His comprehensive treatment of the discussion included an historical analysis of the general tactical bases for the German and Allied operations on the Western Front. The lecture was illustrated by lantern slides. It received enthusiastic comment as a study of the very highest order.

Maj. Roger Sherman Hoar, Ord. Res., a director of the post, presided at the meeting in the absence of the President, Col. W. W. Coleman, which was held at the Milwaukee Athletic Club and to which members of the Milwaukee Engineers Society, the University of Michigan Alumni, the Reserve Officers' Association and the Society of Military Engineers were invited. Mr. Harold S. Falk, President of the Falk Corporation of Milwaukee, introduced the speaker with a few preliminary words in which he stressed the principles of industrial preparedness, the need for educational orders for munitions and the value of the C. M. T. C. Mr. Falk, as special civilian assistant to the Secretary of War, is in charge of C. M. T. C. recruitment in the Milwaukee area.

Colonel Miller's lecture attracted more than 100 members and guests to the dinner meeting. The gathering was one of the most enthusiastic and professionally valuable of the seven years' existence of the Milwaukee Post.

BOSTON POST

THE occasion of the annual meeting of the Boston Post of the Army Ordnance Association on May 21, 1935, took on the added aspect of a farewell to the Secretary of the Post, Major Taylor, who has been ordered to foreign service duty. Major Taylor has assisted in the affairs of the Post for the past four years. ARMY ORDNANCE adds its thanks to those expressed in the following resolution which was adopted by the Post in tribute to Major Taylor:

"WHEREAS the Boston Post of the Army Ordnance Association has a definite and useful purpose in the plan of National Defense and

"WHEREAS the ends to be achieved by it can be attained only by stimulating the interest of its members and

"WHEREAS Major Roger Taylor, Ordnance Department, United States Army, has performed, conscientiously, the duties of Secretary for the past four years by the exercise of military and personal qualities in keeping with the best traditions of the military service, be it

"RESOLVED that the Boston Post of the Army Ordnance Association extend to Major Taylor its deep appreciation and warmest thanks for the outstanding service which he has performed and its best wishes for his success and happiness in his new assignment; and be it further

"RESOLVED that copies of these resolutions be sent to Major Taylor, The Assistant Secretary of War, the Chief of Ordnance, the Commanding General of the First Corps Area, The Adjutant General of the Army and the National Secretary of the Army Ordnance Association; also that these resolutions be entered in the minutes of the Boston Post of the Army Ordnance Association."

SPERRY GYROSCOPE'S QUARTER-CENTURY RECORD

LED by Mr. R. E. Gillmor, president and general manager of the Sperry Gyroscope Company, the group of officials of that company who are members of the Army Ordnance Association are to be congratulated upon the observance of the company's twenty-fifth anniversary, April 19, 1935. These gentlemen have carried on the remarkable engineering work of the late Dr. Elmer A. Sperry, inventor, pioneer and founder of the company.

Twenty-five years ago the gyroscope was little more than a source of amusement to children and scientists; to the former because of its apparent defiance of the laws of gravity, to the latter because it provided endless opportunities for interesting abstract speculations in higher mathematics. Today it is at work in the service of man on thousands of ships and airplanes in the form of the gyro compass, the gyro stabilizer, the airplane gyropilot, the ship gyropilot and the blind-flying instruments: the gyro-horizon and the directional gyro. The record of the company in these fields is attractively and modestly presented in the current issue of *The Sperryscope*.

It is for the achievements of the company in the field of science as applied to our national defense that ARMY ORDNANCE acclaims the organization and its work during twenty-five years. Sperry has pioneered in the development of defense devices. Its searchlight with its 800,000,000 beam candle power bids fair to render well-nigh superhuman results in detecting hostile aircraft, while the Sperry sound locator and antiaircraft director as produced by the company are quite beyond adequate appraisal as defensive mechanisms. "Robot" they have been called with scant justice. The

device, which supersedes the human equation in laying antiaircraft fire on hostile planes, has enabled the national defense of the United States to assume a security against the latest forms of aircraft attack.

As a people we are fortunate in having this highly scientific and successful organization among us. The same applies to many fields and many companies of industrial and engineering achievement in the United States. It applies in a special way to Sperry because following the traditions of its founder, it has developed with rare skill and eminent success its pioneering applications. That ships steer straighter and easier afloat and aloft and that our defense can detect a hostile target and keep it away are public services which add to the glory of the 25th birthday. The skill and proficiency of the individuals who compose the organization and especially those whom the A. O. A. includes in its membership are attested by their works, their products having contributed vastly to the safety of humanity in peace and in war.

AWARDS OF A. O. A. SCHOLARSHIP KEYS

Stanford University

MAJ. GEN. PAUL B. MALONE, Commanding General of the Ninth Corps Area, awarded, on April 8, 1935, two scholarship keys presented by the Army Ordnance Association to students of the Ordnance R. O. T. C. Unit at Stanford University. The awards were made at the annual inspection and review of the Cadet Corps.

The winners of the awards who were the outstanding junior and senior students of the Unit were Cadet First Lieutenant John M. Atkinson of the senior class and Cadet Second Lieutenant Robert E. Jeffrey of the junior class. Both are students in the School of Engineering. Maj. L. A. Miller, Ord. Dept., U. S. Army, is the Ordnance Officer on R. O. T. C. duty at the university.

In describing the presentation, the following account was published in the *Stanford Daily* of April 9, 1935: "Expressing himself as exceedingly well pleased with the excellent showing of the Stanford R. O. T. C., Maj. Gen. Paul B. Malone, commander of the army Ninth Corps area, yesterday visited the campus for his annual inspection. Despite threatening skies and occasional showers a fair-sized crowd appeared at the highway polo field to witness the colorful ceremonies.

"As a feature of the inspection yesterday, several awards for military excellence were presented by General Malone. Before viewing the field artillery parade, the General presented three efficiency awards to ordnance students. Army Ordnance Association keys, given annually to the two outstanding cadets of the local unit, were won by John M. Atkinson and Robert E. Jeffrey. Maj. W. A. Crook Ordnance award went to Kenneth A. Nobs.

"The annual Walter Awards, given to the three seniors who have been most outstanding in military work here, were presented at the review to Herbert W. Winfree, George O. Wilson and Richard O. Hails."

Lehigh University

THE Eighth Annual Field Day Competitions and Military Inspection of the Reserve Officers' Training Corps at Lehigh University was held May 13th at Taylor Field. Included among the many awards made on this occasion were the presentation of two gold scholarship keys presented annually to outstanding students in the Ordnance courses. This year's scholarship keys at Lehigh, awarded to the students having the highest scholastic standing and for displaying unusual interest in ordnance affairs, were won by P. E. Neiman of the 2nd year advance course and L. J. Ertle of the 1st year advance course.

The competition, inspection and award of medals and trophies were part of an all afternoon program which was participated in by all branches of the R. O. T. C. represented at Lehigh. Maj. George C. Donaldson, Inf., representing the Commanding General of the 3rd Corps Area, United States Army, was the inspecting officer. The events included tent pitching, close order drill of the squad, platoon and company, manual of arms, an exhibition of extended order formation and a field problem. The program closed with a regimental parade.

In addition to the awards by the Army Ordnance Association, some fifteen medals and trophies were awarded including, for ordnance students, a set of gold officers' insignia to the member of the 2nd year advance course for excellence in class room work and a gold watch charm to the member of the 1st year advance course for the same honor.

Capt. C. H. Keck, Ord. Dept., Ordnance Officer on R. O. T. C. duty has been stationed at Lehigh for several years. He is leaving the University at the end of this scholastic year for station at 3rd Corps Area Headquarters, Baltimore, Md. He will be succeeded by Capt. T. C. Gerber, now on duty at the Picatinny Arsenal, Dover, N. J.

University of Michigan

THE Ordnance Scholarship Keys awarded at University of Michigan this year were presented to Joseph C. Wagner of the senior class and Charles A. Framburg of the junior class. Both have distinguished records for scholarship and proficiency in military subjects. Mr. Wagner, of Detroit, Mich., is a captain in the Reserve Officers' Training Corps and the Regimental Adjutant. He is managing editor of *The Michigan Technic*, journal of the Engineering College, a member of several national honorary fraternities and societies and the recipient of the Robert Campbell Gemmell and the Simon Mandelbaum scholarships.

Mr. Framburg, a lieutenant colonel of the R. O. T. C. regiment, a resident of Chicago, Ill., also has a distinguished scholastic career. He is a graduate of Culver Military Academy 1932, member of the rifle team awarded the Hearst Trophy Sectional Championship and Corps Area Championship, member of national honor societies and fraternities and captain of the University of Michigan R. O. T. C. rifle team. Capt. R. E. Hardy, Ord. Dept., is the Ordnance Officer on R. O. T. C. duty at Michigan.

University of California

THE President's review of the units of the Military Science and Tactics Department, University of California, was held April 25, 1935. On this occasion awards were made of the scholarship keys presented by the Army Ordnance Association for highest scholastic standing in the Ordnance Unit. The senior award was made to John A. Svendsgaard of Oakland and the junior award to Victor Myer of Berkeley, Calif.

The California Post, Army Ordnance Association, marksmanship trophies presented to the Department of Military Science and Tactics of University of California were awarded with fitting ceremonies on April 11, 1935. The exercises were participated in by all organizations represented at University of California under the command of Col. Harry La T. Cavenaugh, head of the department. The rifle and cup, presented by the Post, were awarded to Eldon O. Dryer of the Ordnance Unit. Also among the awards of rifle team badges Robert R. Moon of the Ordnance Unit received a basic badge and 1935 bar having attained a score of 2313. Capt. S. R. Stribling, Ord. Dept., is the Ordnance Officer on R. O. T. C. duty at California.

Georgia School of Technology

CADET MAJOR F. H. ENDORF of Wilcox, Nebr., was awarded the A. O. A. scholarship key presented to the member of the senior class of the Ordnance Unit, Reserve Officers' Training Corps, Georgia School of Technology, for the highest rating in ordnance scholarship during the past year. For scholarship in the junior class the key was presented to Cadet Sergeant F. M.

Volberg of Atlanta, Ga. Both presentations were made by Capt. N. H. Strickland, Ord. Dept., Ordnance Officer on R. O. T. C. duty at Georgia.

Cadet Major Endorf is an honor student at the University where he has attained each year special distinction in military and regular college subjects. This year he was appointed Major of the Co-op Battalion, the highest rank to which he was eligible. Cadet Sergeant Volberg is likewise an honor student in military and scholastic studies. He also has attained the highest rank, that of Cadet Sergeant, to which a junior can be appointed.

The keys were presented on Military Honors Night when other scholastic awards were made.

Cornell University

AT a review of the Cornell R. O. T. C. units on May 29, 1935, Ordnance Scholarship Keys awarded by the Army Ordnance Association were presented to two seniors in the Ordnance Unit by President Farrand of Cornell University.

The awards were based on grades obtained in Ordnance classroom subjects, averaged with the grades in a selected list of engineering subjects, including mathematics, physics, mechanics, heat power, machine design, etc. The keys were awarded to Robert M. Baker and John H. Schmid. Both students received their commissions as 2nd Lieutenant in the Ordnance Reserve on May 31, 1935.

Mr. Baker is a senior in the Sibley School of Mechanical Engineering at Cornell. His home is at Williamsville, N. Y. Mr. Schmid is a five-year student in Chemical Engineering. He will receive his bachelor's degree in chemistry this year and his degree in chemical engineering as a graduate student next year. His home is in Erie, Pa. Mr. Jean F. Mitchell of Washington, D. C., also a senior in the School of Mechanical Engineering, received an Ordnance Scholarship Key as a junior in 1934. Capt. Merle H. Davis, Ord. Dept., is the Ordnance Officer on R. O. T. C. duty at Cornell.

NEW MEMBERS

THE following have been admitted to membership in the Army Ordnance Association since the last issue of ARMY ORDNANCE: C. O. Bartlett, Bethlehem, Pa.; Joseph S. Bates, Swarthmore, Pa.; Philip Bergmann, Philadelphia, Pa.; J. M. Bradley, Ashland, Kan.; Leon C. Breault, Woonsocket, R. I.; Martin B. Burlap, Philadelphia, Pa.; Jens Clausen, Paxtang, Pa.; G. L. Dawson, East Alton, Ill.; Philip B. Deane, York, Pa.; J. C. Evans, Birmingham, Ala.; John S. Eynon, Chester, Pa.; A. H. Frazer, Xenia, Ohio; A. L. Greene, East Alton, Ill.; J. W. Hennessey, York, Pa.; A. G. Hillberg, Manhasset, L. I., N. Y.; C. L. Jordan, Media, Pa.; S. Forry Laucks, York, Pa.; D. Allen Lenk, Newton Lower Falls, Mass.; E. C. Meinholtz, St. Louis, Mo.; Randolph H. Moultrie, Santa Paula, Calif.; H. L. Mummert, York, Pa.; Kenneth A. Nobs, Stanford University, Calif.; Earl Schroeder, York, Pa.; C. F. Sioberg, York, Pa.; R. Sollenberger, York, Pa.; C. O. Strickler, York, Pa.; Edgar D. Tillyer, Southbridge, Mass.; A. A. Wagner, Portland, Ore.; W. E. Wilkinson, York, Pa.; Charles McC. Wilson, Chicago, Ill.; R. C. Woodward, South Milwaukee, Wis.; I. Laucks Xanders, Baltimore, Md.; and G. S. Zinnecker, Sigourney, Iowa.

NECROLOGY

SINCE publication of the last issue of ARMY ORDNANCE notice has been received of the death of the following members of the Association: A. W. Lorenz, South Milwaukee, Wis.; S. Rosseau, Alton, Ill.; G. W. Schauerte, East Alton, Ill.; and Charles Z. Tryon of Haverford, Pa., formerly a director of the Philadelphia Post. To relatives and friends of these deceased members ARMY ORDNANCE, for its readers, extends condolences.

AOA

Professional Notes

THE HUMAN HAND, WEAPONS AND PROGRESS

By COLONEL R. H. KELLEY, *Infantry*

Director, Department of Experiment, The Infantry School

WEAPONS used for hunting and combat represent evolution dating back to the beginning of mankind. Mechanical devices have always been essential to aid the human being in procuring food and protecting himself against attacks of predatory animals equipped by nature with powerful means of offense and defense. From earliest times men have been weapon and tool using creatures—characteristics forced upon them by the struggle for existence.

By nature man is poorly equipped for survival in a predatory world. He lacks protection afforded by the thick hide of the elephant, the armor of the crocodile, the shell of the turtle. His teeth are of little use in fighting. Compared to the tearing claws of the cat family his finger nails are ineffective, soft and easily torn. Clenched tightly, the hand represents a moderately powerful weapon—the fist. For combat man is severely handicapped.

But man is endowed with one wonderful advantage which is ample compensation for all his physical deficiencies—the human hand. No other creature can touch the end of his thumb to the tip of each finger—a gift not shared by the monkey, ape or baboon. These animals have in effect five fingers which enable them to grasp with limited assurance moderately sized branches of trees and objects neither minute nor very large. An elephant can pick up small articles with the tip of his proboscis but this dexterity is not comparable to work that can be performed by the human hand.

The remarkable flexibility of thumb and four fingers permits men to perform manual tasks requiring precision and complete control. Mental stimulation resulting from ability to use the hand for a multitude of purposes may be responsible in part for progressive development of the human brain. Otherwise handicapped, man has been forced to invent tools and weapons essential to his survival. He continues to progress while all other creatures change little in habits or mentality through successive generations.

Possessing the hand, man is the only creature that can strike at a distance. This statement ignores the prehensile tongue of the toad, power of one snake to eject venom and wide radius of effectiveness common to the skunk family. The strictly animal world is limited in its power of offense and defense to physical contact. Man, however, can protect himself and inflict damage from distances that render creatures without the hand helpless.

Visualizing primitive stages in human development we can picture some early representative of the race discovering that blows with his fist were more effective when stabbing with a sharp rock or splintered bone. This provided man with a fairly efficient substitute for claws. From such pointed articles originated the entire dagger or knife family, weapons known throughout history. Some primitive genius found that he could extend his reach by utilizing a heavy stick. Sharp projections on this weapon led by gradual stages to the sword—in effect a cutting club. Pointing this instrument produced the thrusting sabre. The dagger and sword, both cutting and thrusting, appeared very early in human history and have not changed materially to this day. Another weapon of great antiquity developed from a thrusting stick. This became the pike and exists today as the bayonet and lance, both effective in cavalry engagements. Close physical contact being essential, these means are classed as shock weapons.

Ability of the hand to grasp and quickly release objects led to discovery in some forgotten period that articles could be thrown. This gave man power to inflict injury at distances beyond reach of the dagger, sword, pike or lance.

The first true missile weapons were probably stones. The pike was modified becoming a spear. Other primitive missile devices developed independently in various parts of the world included the arrow, dart, sling and blow gun. With developments in mechanics more powerful weapons appeared such as the crossbow and appliances utilized for throwing heavy stones during siege operations. Missile projecting developed as human genius progressed attaining the considerable efficiency represented by the engines of war used by ancient armies. Designers of these military instruments were known as engineers, a profession later producing "civil" engineers.

Range and effectiveness of missile weapons were measured in hundreds of feet prior to the appearance of powder in the 15th century A. D. Without firearms, hunting wild animals equipped by nature for attack and defense involved great personal hazard. Armies were forced to approach within shouting distance of each other before combat was possible. Physical contact was essential to employment of shock weapons. Before the advent of explosives battle-field casualties often included a great proportion of troops engaged. At Cannae over 70,000 Roman soldiers were killed; less than 20,000 escaped. There were few, if any, wounded. Modern missile weapons forced combat units to abandon compact tactical formations. An interesting paradox follows—as instruments of warfare increased in range and power the percentage of casualties was reduced. Battles of today are less deadly than before the introduction of gunpowder.

Development of explosives gradually increased the range of missile weapons from a few hundred feet to distances measured in miles. Mortars throwing stones weighing hundreds of pounds were used in the capture of Constantinople in 1453—weapons suggesting gigantic coffee cups. From this crude beginning firearms decreased in caliber and increased in range. The pistol, musket and artillery of several sizes were used by Napoleon. Mechanical improvements such as interchangeable parts, an American innovation, were first used in manufacture of small arms and later adopted by the industrial world producing adding machines, typewriters, watches and automobiles. The machine gun and modern artillery include latest advances in missile weapons.

All armies are now equipped with firearms of accuracy and great range. In consequence battle formations of today are characterized by dispersion in depth and utilization of cover. The percentage of men killed with reference to total number engaged is much smaller than when men always fought at close quarters. Military weapons, however, are still designated as shock and missile. The former have changed little in the last five thousand years. Missile weapons change constantly, utilizing every development made possible by modern science.

Without the human hand, however, which permits use of an infinite number of tools, fine adjustments and operation of devices of precision including weapons it is possible that mankind would still be a race of animals with brain power classed with efficiency represented by the hoof, claw and talon.

The 4-Inch Trench Mortar

By Hartley C. Powell
Edgewood Arsenal

THE 4-inch trench mortar was developed by the British during the World War to meet a special need in stabilized warfare. This need required a weapon which could be completely concealed in a trench, could be fired rapidly, and could deliver large quantities of chemical agents at short ranges. This mortar consisted of a barrel, a baseplate, and a barrel support, or bipod. When the mortar was set up in a trench the hemispherical base cap of the barrel rested in a depression in the baseplate which was seated in a recess dug at the base of the rear wall of the trench. This prevented recession of the baseplate. The muzzle end of the barrel was supported at an agle of approximately 45 degrees by the upper end of the bipod, the two legs of which were extended and fixed in the bottom of the trench. The muzzle end of the barrel could be moved within rather narrow limits by means of elevating and traversing mechanisms. The weapon had a range of about 1,200 yards and could be fired at the rate of 25 rounds per minute for short periods of time. As the shell contained about seven pounds of chemical filling, approximately 175 pounds of chemical agent could be put down on the enemy per minute.

One of the most important requirements for a short-range mortar of this type is the ability to go into position, deliver a burst of fire and then withdraw before the enemy locates the weapon and brings it under effective fire.

After the War the Chemical Warfare Service conceived the need of a mortar similar to the war-time trench mortar but with a range approximately twice as great and capable of being set up in a much shorter time. The increased range was secured by rifling the barrel and by the use of a true-flight shell instead of a shell that tumbled throughout its trajectory. The time required to set up the mortar was greatly reduced by using a baseplate that rested on the surface of the ground.

The development of a suitable baseplate for the new mortar proved to be a difficult problem. Since it was necessary to set the baseplate on the surface of the ground it was easy for it to be forced to the rear by the recoil of the barrel. In addition the recoil of the barrel was greater than that of the 4-inch mortar because of the greater pressure developed in the new mortar.

Several methods were tried to prevent the recession of the baseplate. The weight of the baseplate was varied and different sizes, shapes, and arrangements of spades on the under side of the baseplate were tried with unsatisfactory results. The difficulty lay in keeping the barrel, barrel support, and baseplate in the proper relation to each other during the firing of the mortar.

The solution of the difficulty was found in connecting the feet of the bipod to the baseplate so that the entire assembly would recoil as a unit with no appreciable effect on the setting of the mortar. Although this rather simple solution of the problem was not immediately obvious it did not involve any entirely new principle. Both the 6-inch and the 240-mm. trench mortars, artillery weapons, were mounted entirely on heavy wooden bases so that the entire assembly recoiled as a unit although the extent of the recoil was reduced to a minimum by sinking the base into the ground. Similar construction was used by several nations.

As early as 1926 the Japanese Army had a muzzle-loading 70-mm. mortar mounted on a surface-type baseplate which also carried a vertical support for the barrel. Upon firing, the entire assembly recoiled as a unit.

No one person or group of persons is responsible for the idea which resulted in the development of the present surface setup assembly. Among those known to have contributed to the development are the following: Frank B. Hale of Edgewood Arsenal who submitted, in 1924, a design for a surface-type baseplate; Capt. Edmund G. Steis, C. W. S., and Maj. J. C. Akers, C. W.-Res., who submitted, in 1925, sketches showing a bipod-like affair incorporating a baseplate and rests for the regular bipod legs (in commenting on these sketches, A. D. Lewis said that Capt. L. M. McBride, Chief, Mechanical Division, Edgewood Arsenal, had mentioned several times connecting the bipod legs to the baseplate in some manner), D. L. Woodberry of Edgewood Arsenal who submitted, in 1927, a sketch showing baseplate, bipod, and mortar tied together; Capt. C. E. Loucks, Chief, Mechanical Division, Edgewood Arsenal, recommended, in 1928, for future development, a bipod baseplate platform which should be knocked down for transportation purposes and capable of considerable rigidity on setup for firing. It is likely that similar suggestions for securing a stable weapon that would recoil as a unit were made by others also.

The suggestions and ideas referred to briefly above, finally, in July 1928, resulted in the manufacture of an experimental model of a surface setup assembly comprising a surface-type baseplate and a bipod the feet of which were placed in a segment which was attached to the baseplate so that upon firing the entire setup recoiled as a unit. The performance of this model on firing encouraged further development which finally resulted in the present surface setup assembly for the 4.2-inch chemical mortar which has given satisfactory performance in engineering tests.

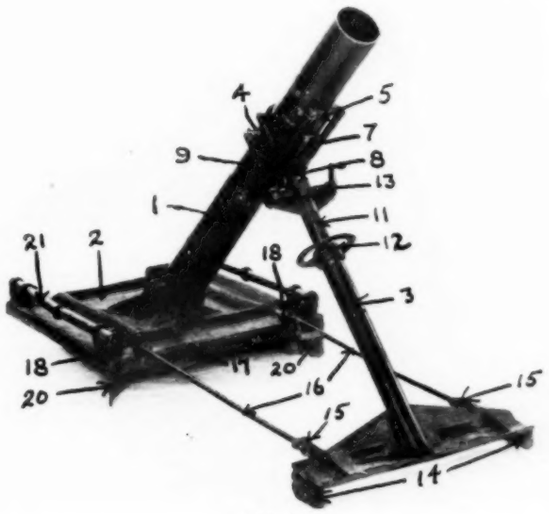


FIG. 1.

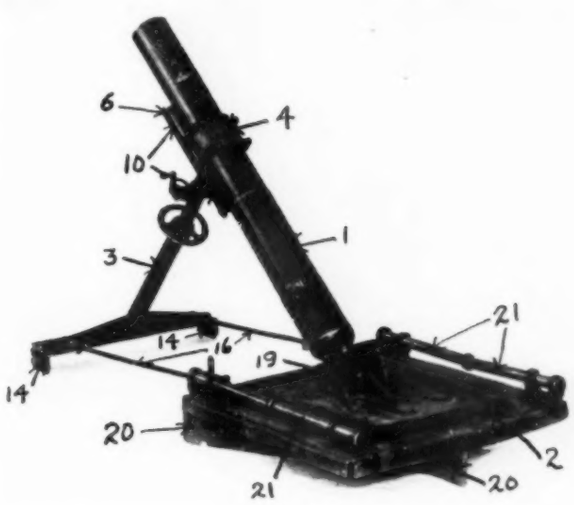


FIG. 2.

The present surface setup assembly, as shown in Figs. 1 and 2, comprises a rifled barrel (1), a surface setup baseplate (2), and a barrel support (3), the base of which is connected by tie rods (16) to the baseplate. The barrel support used in this assembly differs materially in appearance from the one used in the 4-inch trench mortar assembly and is usually referred to as a "standard."

The barrel (1) and standard (3) are connected by means of a large two-piece clamp (4), which is bolted together when assembled on the barrel. The lower half (5, Fig. 1) of the clamp (4) extends in both directions underneath the barrel a little more than 5 inches beyond the bolts holding the clamp together. At the ends of this extension the metal is thickened at the corners which are bent downward to form lugs or ears (6, Fig. 2). In addition the lower half of the clamp has integral with it a slide (7, Fig. 1) with a groove in each side. A shoe (8, Fig. 1) machined to fit the slide is slipped on from the end of the slide. This shoe has two lugs or ears (9, Fig. 1) which project outward and upward, one from each side. Two springs (10, Fig. 2) are used on each side of the barrel clamp, a lug of the shoe separating each pair of springs. These springs when assembled to the barrel clamp have a rod running through each pair, the hole in each lug on the shoe and the lugs at each corner of the lower half of the barrel clamp. When the weapon is fired this assembly (6, 10, Fig. 2; 7, 8, 9, Fig. 1) takes up the shock of recoil with the minimum disturbance of the standard and consequently affects but little the setting of the mortar in relation to its target. The underside of the shoe has a lug projecting downward which is inserted between two upright lugs on the top of the traversing mechanism (13, Fig. 1) and fastened by a bolt through all three lugs, the lug on the shoe being free to turn on the bolt as an axis. This forms the connection between the barrel and the standard.

The standard (3) or barrel support for the surface setup mortar resembles an inverted "T." The stem of the "T" is a hollow shaft which houses the elevating screw and mechanism (11, 12, Fig. 1). The base of the standard has two small metal plates or spades (14) to cut into the ground and prevent excessive side movement. Two eyes are provided (15, Fig. 1) for the tie rods (16) which are used to connect the standard with the baseplate. For carrying purposes, each tie rod has a small flange containing a hole (17) welded to it so that the rods can be brought up and bolted in place between the lugs on the top of the traversing mechanism.

The surface setup baseplate (2) rests flat upon the surface of the ground. At the front edge of the plate near the corners are two hooks (18, Fig. 1) over which the eyes in the ends of the tie rods are placed when the weapon is assembled. The basecap cup (19, Fig. 2) is bolted to the baseplate.

A V-type spade (20) is welded to the underside of the baseplate, the point of the "V" pointing to the rear. This method of using the spade assists in causing the baseplate to move uniformly to the rear. In addition, two small spades are welded to the inside surface of the big spade to restrain the rearward displacement. Telescoping handles (21) are provided on each side to facilitate carrying the baseplate. These handles (21) are normally retained in the positions shown by spring catches and may be extended to the front and rear of the baseplate for transport.

The total weight of the surface setup assembly of the 4.2-inch chemical mortar is approximately 283 pounds, the barrel, baseplate, and standard weighing approximately 90 pounds, 146 pounds, and 47 pounds, respectively.

The minimum range is 600 yards. With a full charge of 1200 grains of disk propellant a range of 2400 yards is obtained with a pressure in the barrel of approximately 5000 pounds per square inch.

NOMENCLATURE OF CHEMICAL AMMUNITION

THE cumbersome names of the several chemical agents, and the numerous classifications to which these compounds lend themselves, have always been confusing to the student of chemical warfare. This problem has been made the subject of much careful study so that a system of nomenclature has been decided upon which it is believed will contribute to that simplicity so important to success in war.

Any system of naming and grouping the various chemical agents must be something of a compromise between the niceties of etymology, the exactness of science and the descriptiveness of military language. Since the soldier is the ultimate user of chemical ammunition the names adopted should be ones that he can readily use and understand. So if the nomenclature now presented lacks something of scientific accuracy the sacrifice may be justified as being in the interest of simplicity.

The noun "chemical" has now attained a unique generic meaning in our military parlance, which includes: a substance producing a physiological reaction, a material generating an obscuring smoke, or an agent causing a primarily incendiary action. Thus we may say that there are three varieties of chemical agents: gas, smoke and incendiary.

A *chemical* officer is then one who is concerned with chemical agents generally, as either a staff or combatant officer of the Chemical Warfare Service. A *gas* officer, on the other hand, is an officer of another arm detailed to duties (usually protective) pertaining to his own arm and related to those particular chemical agents—gases—which produce direct physiological reactions.

These "gas" agents are by far the most important of the military chemicals. Smokes and incendiaries are, for purposes of technical convenience, assigned to the Chemical Warfare Service, and are developed, manufactured and loaded into ammunition by that Service. Yet the real problems of chemical warfare are concerned with the compounds which we now classify as gases.

This term is not entirely satisfactory, insofar as it fails to take into account the several physical states in which these "gases" are dispersed. Yet it is expressive and has attained by usage a distinct and generally understood meaning. The French *gas de combat* and the German *kampfgas* suggest that the solecism does not weigh seriously in other armies. So hereafter "gas" will commonly designate the gaseous phosgene, the liquid mustard, and the solid adamsite.

There are three types of *gas* ammunition which may be supplied. These are: gas, persistent; gas, nonpersistent; and gas, irritant. The adjectives are selfexplanatory. The persistent agents must be avoided in the advance, while the nonpersistent agents may be followed through with fire and movement; both may produce serious casualties. Irritant gases on the other hand are, in a physiological sense, relatively harmless; their persistency is therefore disregarded. In each case, however, the symbol of the agent desired must be added after the descriptive designation. Then, whether this or another agent be actually supplied in filling requisitions will depend uopn the ammunition available, although in no instance will any substitution be sŭch as to prevent the tactical usage planned.

To sum up, a classification grouping of important chemical agents may be presented as follows: *Gas:* persistent (HS); nonpersistent (CG); irritant (CN); *smoke:* (FS), (WP), and *incendiary*.

It is incumbent upon officers responsible for the use of chemical agents to be familiar with the Chemical Warfare Service symbol of each agent. This is necessary because it is this two-letter symbol that appears on each chemical shell, grenade, candle or bomb to indicate nature of content. During the World War the German system of denoting agents by crosses of blue, green or other color, was highly regarded. Symbols are in some respects preferable to such figurative marking; yet even symbols are valueless unless they be understood. It would of course simplify recognition to stencil the name of the agent itself on each munition, but this is impracticable. The symbol must therefore be recognized as representing a particular agent, the general characteristics of which are understood.

Such words as chloracetophenone and diphenylaminechlorarsine are always discouraging to the soldier. It was inevitable that a "common name" nomenclature for chemical agents should have sprung up as reference to particular agents became widespread.

The name "mustard" has clung to dichlorethylsulfide ever since British soldiers first sensed its similarity to natural mustard oil. But this agent is also commonly referred to as yperite and, on occasion, as yellow cross gas. Diphenylaminechlorarsine likewise has come to be variously known as sneeze gas, toxic smoke and adamsite. Resulting confusion necessitates a standardization of the common names of chemical agents.

The common names listed in the following tabulation will serve, in conjunction, where necessary, with appropriate symbols, for the general designation of the indicated chemical agents, leaving their technical chemical names to the use of those who may have real need for them.

Common Name	*CWS Symbol*	*Chemical Name*
Tear Gas	CN	Chloracetophenone
Adamsite	DM	Diphenylaminechlorarsine
Phosgene	CG	Carbonylchloride
Mustard	HS	Dichlorethylsulfide
FS Smoke	FS	Sulphur trioxide-chlorsulfonic acid
WP Smoke	WP	White phosphorus

It is considered that, in the present evolution of chemical warfare, an understanding of the six chemical agents listed above—their characteristics, potentialities and limitations, their common names and their symbols,—will provide the average officer with a substantive knowledge of the currently important chemical warfare agents. In time other agents may replace those now listed, yet probably without disturbing any essential tactical usage. Meanwhile it is desirable to establish clearly in usage the several common names indicated.

As to the striping of chemical ammunition with distinctive bands to denote persistence, it is evident that physically neither incendiaries nor smokes are persistent in nature. Such ammunition is accordingly striped with single bands. On gas shell, however, dual bands are stenciled where necessary to warn the user that such ammuntion will contaminate terrain for considerable periods and that it must therefore not be used in the path of our own advance.

The colors used in stenciling chemical ammunition are clearly indicative of the class of agent. *Green* denotes gas, either persistent or nonpersistent; *red*, gas, irritant; *yellow*, smoke; *purple*, incendiary.

These seemingly elaborate arrangements for making chemical ammunition serve a useful purpose if they assist tired ammunition handlers, in the confusion of battle or at night when lights may be *verboten*, to quickly move up the precise type of ammunition needed.—*Chemical Warfare Service Bulletin.*

Ordnance Patents

In recent months Ordnance patents which have been issued include the following:

To Maj. G. M. Barnes, Ord. Dept., (No. 1,994,458) for a muzzle brake consisting of a number of baffle rings which direct the gases generated in a gun outwardly and rearwardly into an annular chamber surrounding the rings from which chamber the gases are vented.

To Capt. E. C. Goebert, Ord. Dept., (No. 1,993,161) for a welded joint structure envolving the use of a T-shaped strip between the edges to be joined.

To Maj. James C. Karnes, Ord. Res., (No. 1,994,474) for an optical system in which stereoscopic vision in two planes is effected by proper positioning of the objective lenses.

To Maj. Richard C. Coupland, Ord. Dept., (No. 1,997,574) for a firearms discharger equipped with a long recoil for the barrel and a novel firing pin and trigger mechanism. Also to the same officer for an impulse generator (No. 1,998,447) which may be operated either electrically or mechanically; and another (No. 1,998,446) also for an impulse generator which employs an electrical field member to hold the impulse-transmitting element which may be moved out of engagement by the use of mechanical means.

To Forrest K. Howard (No. 1,997,584) for a rear sight provided with a free elevating mechanism on a movable base which may be moved by pressure, having clicks for the elevating and traversing thumb wheels actuated by a single spring.

To Harold G. Towner (No. 1,992,926) for an ammunition fuze intended primarily for use with trench mortars and other smooth bore guns. The invention provides a mechanism which is bore safe.

Ordnance Field Service

ORGANIZATION AND OPERATION OF THE ORDNANCE DEPARTMENT

Part II*

By MAJOR RAYMOND MARSH, *Ord. Dept., U. S. Army*

THE agencies through which the Manufacturing Service conducts its peace-time procurement are chiefly the six manufacturing arsenals, each one of which is specialized along some one or more lines, as for example, Springfield Armory, small arms—Picatinny Arsenal, propellants and explosives—Rock Island Arsenal, field artillery carriages and automotive vehicles, etc.

When an arsenal commander receives the necessary papers constituting an order to him to procure the supplies listed thereon, and making available to him the funds required for such purpose, he has the option either of manufacturing the items involved or of obtaining them through contract from commercial concerns, the prime consideration being to obtain them by whichever method is the cheaper. Procurement through contract is effected in the usual prescribed methods. There are, however, certain exceptions to this, as for example, when the amount involved is under a certain amount, when there is an emergency demanding speed, when competition is impracticable, when secret apparatus of the Ordnance Department is involved, when market price is less than bid quotation, etc. Under exceptional circumstances, purchases are sometimes handled directly by the Office of the Chief of Ordnance. Some of these exceptional circumstances are when the case involves controversial issues, exceptional or patented items, and special items of foreign manufacture.

It will be noted that this organization of peace-time procurement is characterized by decentralized operations with centralized control. While procurement activities are thus decentralized, procurement of particular items or classes of items is highly centralized. Thus Picatinny Arsenal procures all propellants and explosives, Springfield all small arms, Frankford all fire-control and optical instruments. This centralization of procurement by items follows the specialization of the several arsenals. The centralization of control becomes evident when it is realized that nothing can be procured by any Ordnance Department agency unless funds are available. Funds are made available through the Office of the Chief of Ordnance for definite amounts, for prescribed purposes, or for specified items.

THE war-time organization for procurement is based on the organization of the procurement districts. The Ordnance Department maintains 14 procurement districts and 2 subdistricts, grouped into four War Department procurement zones, in accordance with the latest pronouncements of the Office of the Assistant Secretary of War, on that subject. The chief purpose of the procurement district system is to decentralize procurement activities and to effect an equitable distribution of an industrial war load throughout the country. The degree of decentralization required appears to be a direct function of the size and difficulty of the procurement task. For that reason the Ordnance Department finds it necessary to operate more procurement districts than any of the other services. It might be remarked in passing that the biggest industrial problem of the Ordnance Department in connection with procurement is that of the conversion of existing facilities into plants which will produce an item entirely different from that which they normally produce in time of peace. This problem of conversion is in striking contrast to the major problem which the other supply arms and services find in their procurement activities. Here the problem is primarily one of diversion of product rather than conversion.

The equitable distribution of the industrial war load throughout the country is effected through apportionment, survey of facilities, allocation of facilities, accepted schedules of production, and factory plans. These are procurement questions and as such come under the supervision of the Assistant Secretary of War. Apportionment is officially defined as the distribution of primary requirements by the chief of each supply arm or service to the procurement districts for placement with allocated facilities therein. This distribution, or apportionment, is first effected tentatively in the Office of the Chief of Ordnance. Adjustments are made until an apportionment has been obtained which is satisfactory to all the districts. This apportionment must be approved by the Assistant Secretary of War. When so approved, however, it means little more than the approval of the quantitative and geographical distribution of the procurement requirement. Specific facilities must be allocated to the Ordnance Department through the Office of the Assistant Secretary of War. Requests for such allocations are based on preliminary surveys of these facilities, which are made to locate possible sources of production of the item in question. After the facility has been allocated, the way is open for a more detailed survey of the plant, which determines the capacity of the plant and establishes its ability to produce the item in question. The next step is the accomplishment of an agreement, in writing, between the Government and the plant management to the effect that, in time of an emergency, they would be willing to enter into a contract with the Government to produce certain specified items at a certain specified rate. This agreement is known as an accepted schedule of production. The next step in the procurement planning is to prepare a plan for the necessary conversion or expansion of the plant in order to permit it to meet its war-time load. Where expansion merely is required, the factory plan is simple. However, where material conversion is required the factory plan is frequently very voluminous and very much involved. When a factory plan has been prepared and allocations have been made in sufficient quantities to make available a productive capacity equal to the requirements, all of the data with respect to procurement planning for that particular item are collected in what is known as a specific procurement plan. The preparation of a specific procurement plan covering in detail every one of the required items of Ordnance supply is the goal of procurement planning. A specific procurement plan, in order to be effective, must receive the approval of the Assistant Secretary of War. This is within his privilege and in accordance with his statutory obligation, and it is the final step in the supervision which he exercises over the procurement planning activities of the Ordnance Department in its rôle as a procuring agency.

With the completion of a specific procurement plan for any particular item, procurement planning for that item is finished. All of the plans which can be made for the provisioning of that item are made. When the plan is put into operation and the article is procured, either in accordance with the plan or in accordance with the special conditions of peace-time production, then procurement and provisioning of that item are finished. It is then picked up by a supply service, and the functions and operations of military supply begin. It is at this point where procurement ends and military supply begins, that the supervisory authority of the Office of the Assistant Secretary of War ends and control by the military side of the War Department begins.

IT is profitable to pause here a moment and discuss very briefly the relationship between these supervisory functions and military command functions. It is the responsibility of the War Department General Staff to estimate "the forces required and the times

*Part I was published in the March-April issue.

at which they may be needed under the various possible conditions necessitating the use of troops in the national defense," and to prepare "basic supply plans in such detail as will enable the several supply branches of the Army to prepare detailed plans for the accomplishment of their several missions." It is further provided that "in the development of the detailed plans, the branches will request decisions on military questions from the Supply Division, General Staff (G-4), and decisions on business or industrial questions from the Assistant Secretary of War." This means, as we have already described, that the War Department will determine within itself what is wanted, in what quantities the supplies are required, and when and where they are

U. S. Army Air Corps

NANSEMOND ORDNANCE DEPOT.

desired. Equipped with this information, the chief of a supply arm or service, in his procurement activities, comes under the supervision of the Assistant Secretary of War under the provisions of the often-quoted Section 5-a of the National Defense Act of 1920. This might be expressed in another way by saying that the command function of the War Department tells the chief of a supply arm or service what to do and when to do it, and that the supervisory function of the Assistant Secretary of War tells him how and where to perform his duty. This makes the chief of a supply arm or service subject to two sets of orders from two different authorities. But it will be noted that one set of orders pertains to military matters and the other set pertains to business dealings. Because of the fundamental distinction between these two groups of activities, there is nothing inherently incompatible in this arrangement.

Procurement being ended, provisioning is also ended and the problems of military supply, or distribution, must now be considered. Distribution may be broken down into four groups of activities, namely, reception, classification, storage and issue. Procurement being in the main a function of the Zone of Interior, reception of the supplies thus produced will ordinarily be through Zone of Interior installations. Such installations pertaining to the Ordnance Department are under the exclusive jurisdiction of the Chief of Ordnance, exempted from all Corps Area control. A typical installation is shown above.

After reception, the supplies are divided into groups primarily for convenience in storage and the allied functions of inventory and reporting. The Ordnance groups are designated by letters, A, B, C, etc., and each letter group contains similar items of Ordnance supply. For example, Group A contains machine guns, 37-mm. guns, mortars, and their complementary mounts; Group B contains pistols, revolvers and associated individual equipment; Group C contains pack, light and medium field artillery; Group D contains heavy field artillery, etc. This system of classification for convenience in storage has been criticized because it has been felt that the proper basis for grouping should be convenience in issue. When I use the term "convenience in issue," I mean by that all the items issued to a certain military organization should be stored together. For initial issues of equipment such a scheme of storage would be fine. However, initial issues do not constitute either the sole objective, or the major portion of issues of ordnance items of supplies. Normally, but once in the history of an organization is equipment issued in such complete sets. Issues for maintenance and replacement purposes are of equal importance with issues for initial equipment. Storage by associated groups certainly facilitates issuing for maintenance and replacement. Be that as it may, it is a fact that Ordnance property is now stored by groups. To make a change to any other basis would be a tremendous task involving considerable expense. It is my own opinion that after a consideration of the problem, it will be found that the element of quantity of items to be stored or to be issued is the major factor in determining which basis of grouping is the more convenient. Thus, in some cases the present system would be found more convenient, and in other cases a grouping for convenience in issue would be found more convenient.

The items being classified by whatever group system might be in vogue, the next problem is that of storage. This is met primarily by provision for adequate and suitable space. Beginning with the storage phase, the Ordnance Department must begin to exercise its functions of maintenance, modification, alteration and inspection. The problem of maintenance of items while in storage is, at the present time, a problem of major proportions for the Ordnance Department.

FROM the Zone of Interior installations in which supplies are stored, issues in time of peace are ordinarily made direct to the post, camp or station at which the items are needed, correspondence in connection with such supplies passing through the appropriate military channels of supply. In time of war, issues from such Zone of Interior installations would be through ports of embarkation or regulating stations to the Theater of Operations, where the supplies would first be handled through the line of communications establishments, and then after they enter the combat zone, through installations pertaining to the tactical organizations, such as Army, Corps, and Divisions occupying the combat zone. When Ordnance supplies leave the Zone of Interior installations and come into the possession of troops, either in time of peace at their own posts, camps or stations, or in the hands of the supply organization in the Theater of Operations, the Chief of Ordnance loses his direct control of such property. Control is thereafter exercised as a function of military command by the military commander of the unit or area involved. Nevertheless, the Ordnance Department still provides personnel and organization for the proper handling of Ordnance supplies and retains a responsibility for the proper technical instruction and supervision of such personnel and organization. The functions which such Ordnance personnel and organization must discharge are adequately covered by the resumé of duties of a unit ordnance officer set forth in the Staff Officers' Field Manual. It is therein provided that the duties of a unit ordnance officer are—

"(1) Command, insofar as relates to operations, of ordnance troops not assigned or attached to subordinate units.

(2) Adviser to the commander and the staff in ordnance matters.

(3) Supply of ammunition as far forward as the refilling points, and other ordnance equipment and supplies.

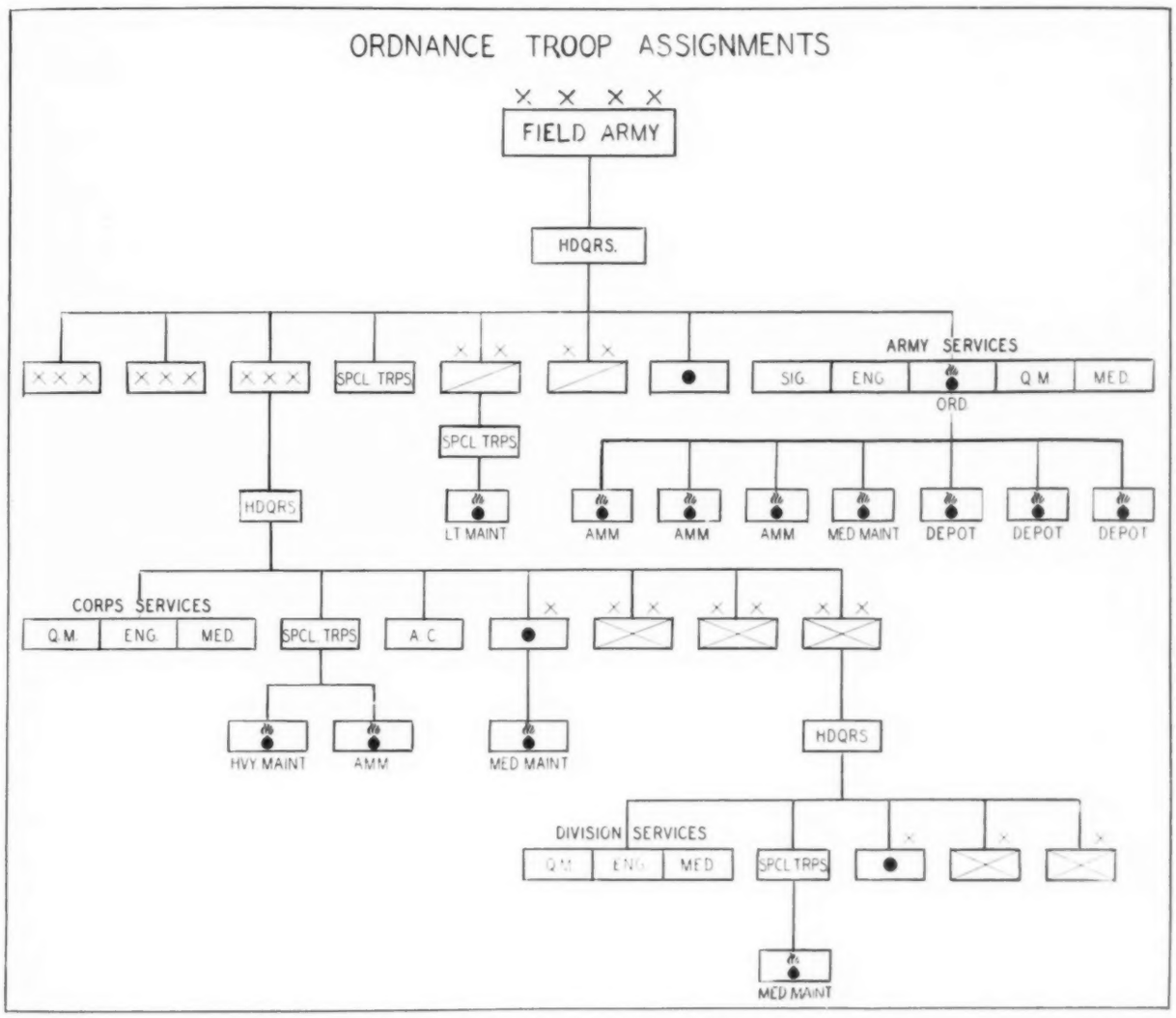
(4) Operation of ordnance storage, maintenance, and repair facilities, including salvage and repair of ordnance matériel.

(5) Technical inspection of ordnance equipment.

(6) Supervision, within limits prescribed by his commander, of ordnance activities in subordinate units.

(7) The collection of information concerning ordnance matériel."

The tasks of Ordnance personnel are not limited to supply and technical advice. They include functions of maintenance, repair,



ASSIGNMENT OF ORDNANCE COMPANIES TO TYPICAL ARMY ORGANIZATION.

modification, alteration and inspection. The personnel and organizations involved in the performance of these duties are Ordnance companies, post Ordnance detachments, post Ordnance repair installations, the Ordnance Officers of military units, corps areas, departments, posts, camps and stations, and the civilian employees assigned to such tasks. The troop units are maintenance companies, ammunition companies and depot companies. The chart above shows the assignment of Ordnance companies to a typical Army. In this type organization there is an Army Ordnance service group consisting of the appropriate headquarters, which is part of the Army headquarters, three Ordnance ammunition companies, one Ordnance maintenance company, and three Ordnance depot companies. It is the function of the ammunition companies to provide the supervisory personnel for Army ammunition depots. The primary function of the maintenance company is the operation of a small-arms repair center. The Ordnance depot companies operate such Ordnance general supply depots as may be established in the Army area. Coming down to the Corps, we find in the Corps troops, in the special troops organization, a heavy maintenance company and an ammunition company. It is the function of the ammunition company to provide the supervisory personnel for such ammunition depots, dumps, or refilling points as may be established and operated by the Corps. It is the function of the heavy maintenance company to support the medium maintenance companies in the lower echelons of the Corps organization. This does not mean that there is a regular flow of unserviceable items from the Division maintenance companies back to or through the Corps heavy maintenance company. It does mean, however, that when a Division maintenance company is confronted with a task which is beyond the capacity of its own particular equipment, that the Corps heavy maintenance company with its more elaborate equipment will be able to help out the Division maintenance company in its repair or maintenance operations. In the Corps, there is another Ordnance unit. This is the Ordnance maintenance company, organically a part of the Corps artillery brigade. Its function is primarily that of maintenance of the artillery matériel pertaining to the brigade. In the Infantry Division there is, in Division special troops, an Ordnance maintenance company of medium characteristics. Its primary function is the maintenance and repair of Ordnance matériel of all classes pertaining to the Division. The latest schedule of obligations of the Ordnance Officer of a Division makes it necessary for this maintenance unit also to exercise some supply functions and to provide a small nucleus of supervisory personnel for the ammunition installations of the Division. In the Cavalry Division, there is likewise an Ordnance maintenance company, but because of the increased mobility of the Cavalry Division, this maintenance company is a light maintenance company. The functions of this group are similar to those already described for the Infantry Division maintenance company.

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Readers can assist in disseminating sane views and current information on Industrial Preparedness and related subjects by recommending their friends and associates for membership in the Army Ordnance Association. Fill in the attached blank and forward to the Executive Offices of the Association, 806 Mills Building, Pennsylvania Avenue at 17th Street, N. W., Washington, D. C.

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NAME .....
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CITY .....

Kindly extend an invitation to membership to them.

.....
Member A. O. A.

THE question often comes up—how does a Division maintenance company operate? Let me touch briefly upon that. As a part of the equipment of a Division maintenance company, there is a quantity of machine tool equipment, tools, etc., pertaining to

ORDNANCE COMPANY, MEDIUM MAINTENANCE, INFANTRY DIVISION

UNITS	HEADQUARTERS & SUPPLY SECTION	SERVICE SECTION	ARTILLERY SECTION	AUTOMOTIVE SECTION	ARMORY SECTION	TOTAL COMPANY	REMARKS
CAPTAIN	1					1	
FIRST LIEUTENANTS		1	1	1		3	
SECOND LIEUTENANTS			1	1	1	3	
TOTAL COMMISSIONED	1	1	2	2	1	7	
MASTER SERGEANT		1				1	COMPOSITE SECTIONS OF THIS COMPANY WILL BE DETACHED AS REQUIRED FOR ASSIGNMENT TO UNITS OPERATING SEPARATELY AND REQUIRING MAINTENANCE FACILITIES
TECHNICAL SERGEANTS		1	1	1		3	
FIRST SERGEANT	1					1	
STAFF SERGEANT					1	1	
SERGEANTS	2	1	1	2	1	7	
CORPORALS	1	2				3	
PRIVATES FIRST CLASS & PRIVATES	10	20	26	45	21	122[A]	
TOTAL ENLISTED	14	25	28	48	23	138	
AGGREGATE	15	26	30	50	24	145	
CARS, LIGHT	2					2	[A] INCLUDES 40 PRIVATES FIRST CLASS 82 PRIVATES
CAR, MOTOR, LIGHT	1					1	
KITCHEN, ROLLING, TRAILER	1					1	
TRACTOR, 5-TON			1			1	
TRAILER, 3-INCH FIELD GUN			1			1	
TRAILERS, WATER, FOUR-WHEEL	2[B]					2	
TRUCKS, CARGO, 3-TON, F W D	3					3	[B] ONE FOR RESERVE WATER FOR VEHICLES
TRUCK, TANK, GASOLINE	1					1	
TRUCKS, SMALL ARMS REPAIR					3	3	
TRUCKS, LIGHT MACHINE SHOP, M1		1	1	1		3	
TRUCKS, LIGHT REPAIR		1	1	1	1	4	
TRUCKS, SPARE PARTS		2	4	4	2	12	

what we call a general service section. There is, in addition, certain equipment pertaining to the other sections of the company, namely, the Artillery section, the Automotive section, and the Armory section. This equipment includes heavy trucks and some lighter trucks, of characteristics generally known as light repair trucks. These light repair trucks are used primarily for the purpose of transporting small repair crews with the necessary tools, spare parts, and other materials, to locations where unserviceable matériel has been collected, may be brought, or is located. These repair crews complete the repair right then and there if it is possible to do it with the facilities at their disposal. If the additional shop facilities of the company equipment are required, then the unserviceable item is transported to the company bivouac and there repaired. It frequently happens that shop facilities in excess of those available to the company are required for the proper repair of an unserviceable item. As I have indicated above, the first point of supply for such additional facilities is the Corps heavy maintenance company. If the facilities there are inadequate to perform the necessary repair then the unserviceable item must be evacuated through the regulating station to the appropriate repair organization in the line of communications.

I have said nothing which would indicate the size of the procurement task which the Ordnance Department will have to meet in time of war. I have not brought out the fact that in the battle of the Somme, the British fired 75,000 tons of ammunition which would require 1,500 freight cars of 50 tons capacity, or a train over ten miles long, whereas the artillery ammunition expended by the Union forces in the battle of Gettysburg would require only eight such cars. I have not mentioned any of the achievements to which we may justly point with pride, which the Ordnance Department has accomplished in the last few years, such as the development of the present antiaircraft artillery director, the torque amplifier, the removable liner for antiaircraft weapons, the centrifugal casting of guns up to 6-inch in caliber, and the cold-working of monobloc weapons of the same limiting caliber. These facts, while important and interesting, are nevertheless incidents in the Department's performance of its duties and are not fundamentally connected with either its organization or its operation. (*This series will be continued in the next issue.*)

Book Reviews

TEXTBOOK OF FIREARMS INVESTIGATION, IDENTIFICATION AND EVIDENCE. In One Volume with Textbook of Pistols and Revolvers. By Julian S. Hatcher. With a Foreword by J. Edgar Hoover, Director, Federal Bureau of Investigation, Department of Justice. Marines, N. C.: Small Arms Technical Publishing Company. 1935. $7.50 postpaid.

THE generous size of this volume just received makes it impossible for us to give a complete review of it until our next issue, but a preliminary examination shows that it is an 875-page book of 27 chapters, illustrated with 270 excellent photographs and drawings.

The author is well known as a firearms expert. Now Lieutenant Colonel in the Ordnance Department, he has filled many posts of technical and administrative responsibility in the Regular Army. His "Textbook of Pistols and Revolvers," which is included in the present volume, is not to be confused with "Pistols and Revolvers and Their Use" published in 1927. He is a frequent contributor to pages of ARMY ORDNANCE.

A valuable feature of the book is the fact that it covers the elementary and advanced phases of its subject in such a comprehensive manner that it should be equally useful to both the beginner and the technically qualified expert.

The reader who wishes to fit himself for court work in firearms will be particularly gratified by the fact that the book lists all the tools and instruments needed by the specialist in this work, together with prices and sources of supply as well as full instruction for their use.

The voluminous tables of data of all kinds make it a veritable reference encyclopedia of firearms information, while the extensive digest of court opinions and the bibliography of 163 items should make it an invaluable addition to the library of every law enforcement agency and practicing attorney.

We regret that when the present volume was received there was not time for the preparation of a definitive review for this issue of ARMY ORDNANCE. More will be said of it in a subsequent issue. In an effort to give an idea of the scope of the work at this time we can do no better than to quote from the foreword in which Mr. J. Edgar Hoover, Director of the Federal Bureau of Investigation, Department of Justice, writes:

"Publications on the identification of firearms, a subject so vitally important to modern law enforcement and prosecution, have in the past been inadequate in scope, and consisted largely of scattered articles, published in the various peace officers' and technical journals, each article dealing with only a limited phase. Further, these articles were always difficult to obtain, and more difficult to search for some desired point.

"Hence Maj. J. S. Hatcher's book, "Firearms Identification," is particularly welcome, and a pre-reading of its chapters indicates that he has produced just what I was confident he would, a comprehensive, accurate treatise.

"Major Hatcher is well able to produce an authoritative book, for he has long been recognized as a conscientious, capable, and scholarly expert. I am proud that he has coöperated in the work of the Federal Bureau of Investigation by serving as a member of its training school faculty, giving newly-appointed special agents the benefits of his theory and practice. The manner in which these men have grasped his instruction shows that he not only knows the subject of firearms identification, but can present his ideas well.

"By its meticulous emphasis of every important detail, this book should do much to discourage that dangerous practice of recent years wherein law enforcement agencies purchase microscopes and expect the fingerprint experts in their departments to overnight become experts in the analysis of firearms evidence, and to carry on such work in their spare time. At the same time it should do much to impress upon these law enforcement agencies the great importance of the proper evaluation of firearms evidence in criminal cases by an impartial expert who devotes his full time to mastering the intricacies of this science. Expert testimony on the subject has been sufficiently tried in the courts to clearly establish its value when prepared by an honest technician, fully qualified in the science and appreciative of its limitations when the quantum of available data concerning the evidence is not sufficient. In crimes where firearms have been used, expert analysis of the resulting evidence is as essential to the investigation as the questioning of witnesses or any other phase of the inquiry made by a thorough investigator.

"Major Hatcher's volume will be welcomed by both the conscientious student and the expert. The orderly arrangement of his material seems admirably suited, either as a logical sequence of study or for ready reference by the expert. In readily understandable statements he explains much of the bewildering terminology descriptive of the great variety of ammunition and weapons which are now, or have been on the market in recent years. From years of association with, and research into the many ramifications of the entire subject of firearms, the author is particularly well qualified to arrange the problems in a logical order and to properly determine the amount of attention best given to each.

"Although indisputably a technical treatise, the book makes tremendously interesting reading and should be particularly fascinating to that great army of 'gun cranks' who find the study of firearms and their loads an intriguing hobby. The Judiciary will find it an instructive reference work and an authoritative one." O. E. D.

THE STRATEGY OF RAW MATERIALS: A STUDY OF AMERICA IN PEACE AND WAR. By Brooks Emeny. New York: The Macmillan Company. 1934. $3.00.

DOCTOR EMENY here presents a study of our capacity for industrialization—the touchstone of power in war and peace of this modern economic age. The basic material of the work was presented for the degree of Doctor of Philosophy at Yale University. The publication is under the auspices of the Bureau of International Research of Harvard University and Radcliffe College. The compilation of statistics and the arrangement of invaluable charts and maps grew from data furnished by various officials and organizations, governmental and private. Since publication, the author has collaborated with Mr. Frank H. Simonds in the recently published work "The Price of Peace."

Students of national defense have long wished for a concise, authentic analysis of the fundamental answers oi these fundamental questions: a. To what extent could the United States, on the basis of its own resources, meet the demands of self-sufficiency in the essential food stuffs and raw materials in time of extreme war emergency? b. As to those specific commodities for which we should be partially or entirely dependent upon imports, what sources of supply might be available from foreign countries under various contingencies of war? c. What specific measures could be adopted as a means of assuring our self-sufficiency under all war contingencies?

Until now the answers to these vital questions have not existed in readily available form so that students have often floundered for correct and inclusive data. By his clear analysis Dr. Emeny discusses all the critical commodities, the relations of the seven great world Powers to them and the unusual combination of circumstances which could apply to the United States in time of

war. His textual presentation is superb. The maps and charts which accompany the text are quite the most expressive visualization of the various situations we have yet seen presented.

The Strategy of Raw Materials must take its place among the essential handbooks of the student of national defense. Possibly its appearance at this time will serve the very necessary purpose of clearing an atmosphere so frequently beclouded by non-factual and ill thought out theories of war prevention. Dr. Emeny writes of basic things, the ingredients of the national and international economic machinery which are the underlying causes of happy or unhappy relationships. The distribution of these basic things throughout the world, the dependence of peoples and states upon their supply and the ability to meet or not meet the requirements of major emergency are here described in full. The advocate of "mineral sanctions" will find much to alter the practicality of his theme.

In the preparation of this work Dr. Emeny acknowledges his gratitude to the defense services of the United States for their cooperation. They, in turn, and all other students of the potentials of war and peace who know full well that national strength is revealed not nearly so much on the battlefield as it is in the factory, will make no delay in acknowledging their debt to the author. Here is shown that capacity for defense is measured in terms of possession of basic raw materials of industry. Few are the states enjoying these advantages. The United States by virtue of its position is indeed a great world Power. For this study of our strategic raw material position in contrast to that of other industralized Powers the author deserves all praise. O. E. D.

THE ARMY IN MY TIME. By Major General J. F. C. Fuller. London: Rich & Cowan, Ltd. 1935. Six shillings, net.

GENERAL FULLER'S latest, "The Army," is one of a series of fourteen uniform books, known as "In My Time." It is rather small as biographical or historical works go, only 246 pages, but is well packed with information and opinion. The author frankly states in his preface that he attempts no "history" of the British army, but rather a criticism, or, in his words, "a character study." This seems quite wise for it makes the volume a well written and easily read compendium and lends itself well to a discussion of the author's special interest—mechanization.

Because of the vastness of the subject, the chapter on the World War has been especially summarized, and reduced largely to figures. The statistics used are excellent, and are very well chosen. Part IV, which has been titled "To-Morrow," is brilliantly done despite opinions from which this reviewer must strongly differ. Especially outstanding is the chapter on "The Command," with which the author ends his book.

General Fuller is well known throughout the world of military students as an expert on army mechanization and as the leader of the "Fuller school" of tank enthusiasts. The author displays both the strength and the weakness of the specialist and enthusiast. He knows his subject and drives it home at all times but, by frequent exaggeration and by almost completely ignoring the arguments against the tank, he may cause the average reader to discount much of the author's argument for the tank as "special pleading." His great admiration for, and belief in, extreme mechanization makes him impatient of all opposition. The refusal of the British army to see eye-to-eye with him on the subject causes him not infrequently to indulge in extremes of criticism which seem hardly fair or just: as when he says that "the British officer lacks only a knowledge of his profession." This is surely too sweeping an indictment of an entire army! In this connection, readers of General Fuller's recent "Grant and Lee" will recall, what another reviewer in ARMY ORDNANCE of last July-August called "the strangely shrunken and curiously distorted figure of Lee" as drawn by the author. As that reviewer well said "there is no evidence to support such a view." Yet, with all these weaknesses, "The Army In My Time" is a most readable and worthwhile work. The highly controversial points which bring out the author's weaknesses also stimulate the interested reader to thought and to further study. Surely this is enough to ask of any book!

Though bound together with much interesting and well chosen historical summary and anecdote, the real meat of "The Army In My Time," falls into two main critical studies. These are, first: Discipline, Command, and Military Policy; and second, Mechanization in Land Warfare.

On the first, most military students will probably agree with most of General Fuller's conclusions. Some of these are: that the British army is "trained for peace rather than for war"; that it is looked upon by the Government as a police force and looked down upon by the people; that it is starved by politics and subordinated to "petty financing"; that it is almost unknown to the people; that discipline still leans too much to the Prussian system; that the higher command has lost touch with the rank and file, and fails in an emergency because the men "want blood, not ink"; and that an army in a democracy is under a staggering handicap. Most of these conclusions are applicable in greater or lesser degree to the American army, as well as to the British, and provide quite an interesting comparison between the two.

With General Fuller's conclusions on mechanized warfare, this reviewer radically differs. The General seems blinded by his tremendous enthusiasm for his own specialty. Many of his statements in discussing this question contain some truth, but he is entirely too sweeping in his claims and too one-sided in his viewpoint. Thus he says that with tanks of the present time, "you have cut the bullet out of the picture." Quite an exaggeration, even without considering the Gerlich bullet—still only in its infancy—and already dangerous, if not fatal, to any tank in existence or in sight. General Fuller's explanation of the many failures of the tank is, substantially, that they were caused by "idiotic hampering by the G. H. Q. mind." Coming from such an enthusiastic specialist, who demonstrably exaggerates on many points, this of necessity must be strongly suspect. His argument for the use of tanks without infantry support is unsound, for tanks cannot successfully attack infantry that is well equipped with antitank defense and trained in its use. He almost completely ignores the grave limitations of tanks under actual conditions of open warfare; that they cannot permanently occupy captured positions; cannot mop-up large towns or heavily broken ground; cannot attack well fortified points; cannot pursue even a thoroughly demoralized enemy into heavy woods, swamps, etc.; and that scattering of infantry would compel scattering of pursuing tanks, and subject them to prepared ambush. According to Artillery General von Eimannsberger, in *Der Kampfwagenkrieg*, the German army failed to concern itself seriously about either the use of tanks or defense against them. As General von Eimannsberger is generally classed as definitely of the Fuller school of tank students, this would seem to indicate that the World War offers no criterion of the question.

On the other hand, most readers will agree with General Fuller's criticism of the use of slow tanks and of the neglect of serious development of this weapon. It is obvious that the tank will greatly modify warfare of the future, though much less completely and probably less swiftly than its enthusiastic advocates would have us believe.

The question has frequently arisen in the minds of many observers, why, if what Fuller, Hart, Nickerson, and a few others, say of the tank, is true, is it a fact that all nations, now straining every nerve for "security," still depend on mass armies of infantry and artillery? Proponents of mechanization have not, as yet, presented an answer to this question. It will be of consuming interest when it comes! Let us hope that they do not merely say that "mass armies are easier," or "their leaders are blind"; for either would be equivalent to saying that all military men, except the small group of "tankers," are fools! F. W. F. G.

ORDEAL BY FIRE. By Fletcher Pratt. New York: Harrison Smith and Robert Haas. 1935. 479 pp. $3.00.

THE author speaks of this book as an informal history of the Civil War, and announces that his aim has been "to follow the main currents of fact and emotion during the War; to include practically everything that contributed to the final result and to omit nearly everything else." But let not these candid statements trick the military student into neglecting the entertaining work that Mr. Pratt has provided. Informal it may be, an affair of dinner jackets rather than white gloves and "tails," but this is one of those rare occasions when history and literature have been merged, when the noble drama in which our grandfathers were the actors is presented as a fireside tale fraught with all the grandeur, all the intense feeling, and a fair sample of the humour that marked the War Between the States. Though this may differ from our concept of written history, no undue liberties have been taken with facts or incidents. It is the old familiar story, but told by a wily raconteur who avoids with laudable consistency the ever present temptation to stray from the direct path. In truth, so judicious have been the omissions and so sagacious the inclusions, that events seem to flow on relentlessly to the logical climax. It is history that will linger in one's mind, it is an achievement in prose that can claim its place on the shelf beside Stephen Vincent Benet's "John Brown's Body."

The first chapter opens with the ominous pre-inaugural scene in Philadelphia where it was expected that an attempt would be made to assassinate Abraham Lincoln. The final page of the book describes the consummation of that tragic deed. Within these time limits there took place the astounding clash of two non-military republics. The nature of this conflict the author fully appreciates, transmitting to the reader the sense of indecision, groping incapability, and ignorance of war that characterized the first efforts. With remarkable economy of words the important actions are described, and more thrilling battle narratives are hard to find in print. From the conduct of the struggle as a whole a significant thought is extracted which bears upon the different cultures of the South and the North. The former kept the same leaders throughout the war; her development had reached its climax and her guiding principles were to preserve the status quo. The North, on the other hand, started slowly and badly, but improved as time went on and so did her leaders. Younger men came to the front until, in the summer of 1864, the movement had assumed a surprising rapidity, and with it developed the military art which culminated in the amazing campaign of that year, extending in space from Mobile to Richmond. While the South strove to prevent change, the North progressed.

As the various characters appear upon the scene, they are introduced with a skillful touch that conveys something of the impression that they made upon the rank and file; J. E. B. Stuart with his arms full of girls, Phil Sheridan's "Here's how" before he climbed Missionary Ridge, Thomas "bellowing like a bull." In the beginning the personalities of the leaders meant much to the armies, but by 1863, it is pointed out, the Northern forces had become trained military units. They had learned to do their duty capably, and, as at Gettysburg, reasonably competent officers were sufficiently numerous in all grades to insure ultimate success. The acuity of Mr. Pratt's grasp of military problems is not obscured by his rapid style and quick flashes of humour. "Ordeal by Fire" is a distinguished work, and it may not be out of place to congratulate Messrs. Harrison Smith and Robert Haas upon their share in making it available to the public. J. M. E.

CHASING VILLA. The Story Behind the Story of Pershing's Expedition into Mexico. By Col. Frank Tompkins. Harrisburg, Pa.: Military Service Publishing Co. 1934. $2.50.

EXCEPT for a few isolated articles appearing in the various service journals, this is the first account of Pershing's Punitive Expedition to be published. In the foreword, Gen. Harbord

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intimates that this book records the last achievement of the old horsed cavalry. It may or may not do that, but it does record partially the last achievement of the old pre-war Army.

Briefly, the story of the Punitive Expedition is this. Beginning with the downfall of the Diaz régime in Mexico, the story of the international relationships of the United States and that country rapidly became a recital of pillage, depradation, outlawry and diplomatic literature. On the Mexican side it was marked by a complete disregard for American life, property and rights. On the United States side it was marked by Bryan's pacifistic idealism, President Wilson's personal whims, vacillation, diplomatic ultimata and "watchful waiting." The policy of "watchful waiting" was finally rewarded by Pancho Villa's raid on Columbus, New Mexico, in the early hours of March 9, 1916.

A week of diplomatic exchanges followed and on March 16th two columns of United States troops entered Mexico, one from Columbus and the other, farther west, from Culberson's Ranch. Reaching Colonia Dublan, some 125 miles south of the border, three cavalry columns took up in detail the search for and pursuit of Villa. These operations lasted not quite two weeks and produced but one contact with Villa's forces—the fight of Col. Dodds' column of the 7th Cavalry at Guerrero. These three columns returning to their base, four others were formed which operated until the middle of April. One of these columns—Col. Tompkins' squadron of the 13th Cavalry—had the fight at Parral, which was the "high water mark" of the expedition. Diplomatic representations from the Mexican government caused our State Department to limit Pershing's activities and a period of uncertainty followed. However, all clues as to the whereabouts of Villa or any of his band were pursued as far as our State Department would permit. The fight of Major Howze's squadron of the 11th Cavalry at Ojo Azules, the killing of Villa's lieutenants, Cardenas and Cervantes, and finally the Carrizal affair on June 21st with the killing of Captain Boyd and Lieutenant Adair and the scattering of two troops of the 10th Cavalry, brought to a close the active operations of the Punitive Expedition.

The troops remained in Mexico until February 5, 1917, when the last unit recrossed the border at Columbus. Meanwhile, a commission at New London continued their conversations in efforts to end the unpleasantness, and Villa, healed of his wounds, and with his army again recruited, once more became a thorn in the side of the *de facto* Mexican government, despite the fact that President Wilson had specifically directed "that an armed force be sent into Mexico with the sole objective of capturing Villa. . . ."

This book is called the story of the Punitive Expedition. After portraying splendidly the historical and diplomatic background of this phase of the United States—Mexican relations, it is limited largely to a recital of the part played by the cavalry in the expedition. The feat of Battery "B," 6th Field Artillery, in marching 145 miles in 46 consecutive hours is covered in but one paragraph; no mention is made of the marches of the battalion of the 4th Field Artillery; the night march of Batteries "B" and "C," 6th Field Artillery, unescorted, without guides and through prairie fires, from Lake Itascate to San Antonio to support the cavalry concentration at that point, is not noted; the achievement of the Signal Corps in maintaining wire communication as far as it did is unmentioned; and no account is given of the Herculean task, accomplished finally by the truck companies, of supplying 10,000 men stretched out over 300 miles of roadless Mexican terrain.

It is unfortunate that the book was not more carefully edited. The many fascinating and thrilling episodes which are reported are too liberally sprinkled with instructions as to how to take care of a horse, what a good cavalry leader does, and primer-like statements as to how minor tactics are executed. There is a defensive strain throughout the book which is so pronounced that the casual reader will be led to believe that some things or persons need defense. Nevertheless, the book fills a great need and merits

the interest and careful reading of any one connected with or interested in the Army. No matter what may have been endured in France, it is a fact that for individual fortitude, endurance and devotion to duty under the adverse conditions of sweltering days, freezing nights, chilling winds, biting dust storms, short rations, forced marches, night operations, scanty clothing, hostile populace and treachery of alleged allies, the Punitive Expedition is second to none. R. M.

SOLDIERS UNMASKED. By William Addleman Ganoe, Lieut. Col. U. S. Army. Hartford: The Pyne-Davidson Company. 1935. $1.50.

THIS little book of 136 pages comes as a breath of refreshing good sense amid the torrid blasts of current radical attack upon the United States Army and its work. Colonel Ganoe is the author of the renowned History of the United States Army. In addition to his many scholastic and literary attainments and his present important professorship of military science and tactics at Boston University he was, for a time, much to the honor of ARMY ORDNANCE, a member of its editorial board.

The subject matter of this text discusses the work of the soldier. It narrates the great contributions of our military men to the material and cultural advancement of the United States. It analyzes some of our historical military monstrosities prior to and during our major wars. It presents a picture of the unmasked —the true—soldier of the United States. This book should be read by every thinking American of all ages and of all classes of society *today*. We wish that someone would place a copy in the hands of American youth, our college students, our women's clubs, our grotesque pacifistic organizations, our university professors and indeed of the members of our Army itself.

Here is a concise refutation of the many unwarranted attacks upon our Army and an indictment of the *laissez faire* attitude of the American people on questions of national defense for generations past. To describe Colonel Ganoe's work adequately or to cite individual instances as recorded by the author would be to republish the text in full.

Some months ago a former West Pointer published a bitter attack on the United States Military Academy under the title "Tin Soldiers." His is the type of writing which masks the American soldier. Qualified, sincere and factual writers like Colonel Ganoe do well when they unmask him. Our soldiers unmasked are the backbone of authority and discipline among us. Too many of our people are led to believe otherwise. Colonel Ganoe presents the truth—glorious for soldiers and inglorious for the muckraker—that all may read. We hope they will. O. E. D.

THE SECESSION MOVEMENT IN VIRGINIA, 1847-1861. By Henry T. Shanks. Richmond: Garrett & Massie. 1934.

IN an 800-page history of the United States which I have in my library, secession is covered in the index by but seven references. The secession of South Carolina is duly chronicled and accompanied by the statement that "she was ahead of Virginia, which was not a cotton state, and whose ancient Southern leadership was now little more than a name." The actual secession of Virgina is covered by the brief statement that "The attack on Sumter showed the slave states still in the Union that they must fight for or against the Confederacy, and four of them quickly joined the seven which had already seceded. They were: Arkansas, May 4; Virginia, May 17; . . ."

This is typical of the brief way in which many historians have treated the secession movement in Virginia. Yet it is a fact that Virginia's decision on the question of secession was more anxiously awaited by both the North and the South than was the decision of any other state. Her population, resources, and wealth were greater than those of any other slave state. Her history and prestige gave her an influence in all sections of the country which was eagerly wanted by both sides. Her position on the

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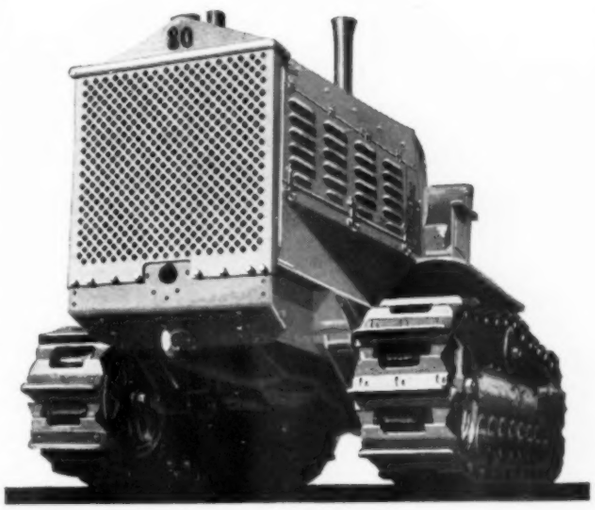

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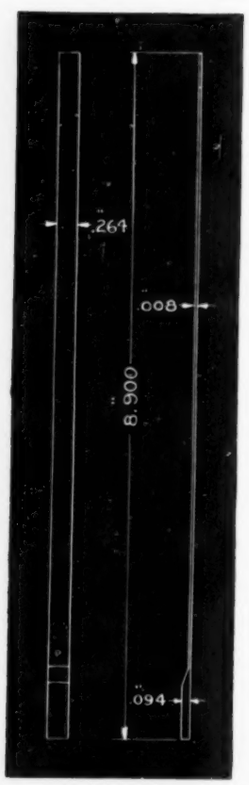

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border of the admitted free states of Ohio and Pennsylvania and separated from the Nation's Capital by only the Potomac River gave her a strategic importance of the highest order. She joined the Confederacy after but slight delay. The student of history is prompted to ask "Why?" and further, in the light of her history, "Why was she the ninth state to secede, instead of being one of the first?" Were the motivating factors in this drama political, economic, historic, or sentimental? Was it slavery, states' rights, or Southern nationalism?

Professor Shanks answers these questions in this scholarly and critical study to which he has devoted some eight years of research, during which he has had access to material heretofore unavailable. Without condemnation or excuse for Virginia, her leaders and her moulders of public opinion during these fifteen critical years, Professor Shanks traces the course of events and the pendulum-like swings of public opinion during this period. Personalities are portrayed, conflicts are depicted and political upheavals are recounted, but only incidental to the development of the secession movement.

This book is probably the first real critical study of this phase of American history. It is carefully done. The meticulous care with which references are cited and sources mentioned leaves no room for doubt as to its historical accuracy. It fills a big gap in the historical writings of one of the critical periods in American history. R. M.

THE IDENTIFICATION OF FIREARMS. From Ammunition Fired Therein. With an Analysis of Legal Authorities. By Jack D. Gunther and Charles O. Gunther. New York: John Wiley & Sons. 1935. $4.00.

THIS 327-page volume is the work of father and son. Jack D. Gunther, the son, is a member of the New York State Bar; Charles O. Gunther, the father, is Professor of Mathematics at the Stevens Institute of Technology, a Lieutenant Colonel in the Ordnance Reserve Corps and a charter member of the Army Ordnance Association. Father and son have combined to produce a timely addition to the literature of firearms identification. Their work is all the more welcome at this time because, while there has been an abundance of periodical literature on this young and rapidly growing science, the present volume and one other* are the only two American books on this important phase of crime detection and law enforcement.

The book is divided into three chapters, of which the first deals with certain technical aspects of bullet and cartridge examination, the second discusses in some detail the famous Sacco-Vanzetti trial, and the third is concerned chiefly with extracts from the records of trials involving firearms identification of one sort or another, with particular emphasis on the mistakes, shortcomings, and lack of proper qualification of certain quoted witnesses.

Chapter 1, containing 103 pages, or just a little less than one-third of the book, starts with a brief statement of the problems involved in court work on firearms identification, followed by a very brief description (or we might better say, enumeration) of the various kinds and classes of guns, powders, and cartridges. Then there are several pages on work with the microscope, and a very interesting and pertinent short statement regarding tool marks and the character of the irregularities found on machined surfaces. The remaining 70 odd pages of this chapter are devoted to a discussion of several pertinent points relating to the technique of bullet and cartridge examination. This chapter has a number of excellent and very helpful enlarged photographs of bullets and cartridge cases, which well illustrate the several points discussed in the text.

Chapter 2, containing 143 pages, or slightly less than half the book, is devoted entirely to the Sacco-Vanzetti case, with volumi-

*Textbook of Firearms Investigation, Identification and Evidence, reviewed on page 369. Students of firearms identification will anxiously await the work of Lieut. Col. Calvin Goddard, Ord. Res., a pioneer in the field, who is now engaged in the preparation of an advanced treatise on the subject.—Editor.

nous transcripts of the testimony of the various persons who appeared in that trial as expert witnesses on firearms. The errors of these expert witnesses are pointed out and commented on most pitilessly, the object evidently being to give a "horrible example" of firearms evidence as it should not be. The highly caustic comments on the various experts and their testimony are interesting, but the reader should remember that this trial occurred before the science of firearms identification as we know it today had come into existence. To the modern firearms expert witness, who has had the benefit of the pioneer work of Goddard, such testimony seems unthinkable, but it is entirely likely that some of our present day experts, if put on the stand at that time, would have made an even sorrier showing.

The authors, in their review of the Sacco-Vanzetti case, give the impression that they rather think that the two defendants were wrongly convicted, and certainly we can agree that the testimony of the firearms experts was far from being the kind of evidence on which a conviction should be based; yet on p. 114 the authors show a composite photograph of one of the evidence cartridge cases and one of the test cases fired from the pistol found on Sacco, which clearly indicates that both cartridges were fired in the same gun.

Chapter 3 contains 82 pages of "Analysis of the Authorities on Firearms Identification." It consists of comments on extracts from the records of trials, or of decisions on appeals from trials, which involve points on firearms identification. The material is interesting to anyone, and is valuable to the attorney who may have to do with trials involving crimes with firearms. Not the least interesting and useful of the contents of this chapter are several pages of suggested questions to be used for the purpose of showing what qualifications are possessed by a witness, and of exposing the utterly deficient and unqualified witness.

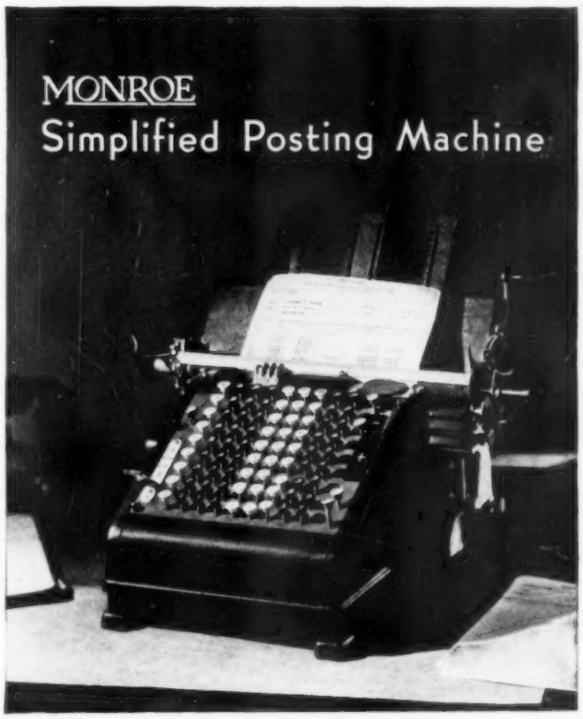
This volume will be found to be of value both to the practicing expert witness on firearms, to whom it will give useful additional information on several phases of bullet and cartridge identification, and particularly to the attorney who may have to do with fireams cases, to whom it will give assistance both in selecting his own expert and in exposing any deficiencies of the opposing expert through cross-examination. J. S. H.

THE MONKEYS HAVE NO TAILS IN ZAMBOANGA. By Capt. S. P. Meek. New York: William Morrow & Co., Inc. 1935. $2.00.

WHYEVER should so staid and stalwart a publication as ARMY ORDNANCE include in its book review column such a volume as this? Could it be because there is some hidden military significance in the stories of the explosive mule, versatile cows, changeable horses, humming hens and elastic hogs? These are the titles of some myths of which the author writes.

It is not because the monkeys have no tails in Zamboanga that this review appears here. The reason must be found in the authorship. Captain Meek is a charter member of the Army Ordance Association and an officer of the Ordnance Department, United States Army. Between times when not exhausted after wrestling with differential calculus, interior ballistics, ammunition supply and other ordnance "chores" he finds time to wield the captivating pen of fiction. He is the author of other volumns which have delighted young and old alike. His versatility is not limited to nature stories as is shown by the fact that in past years he has contributed technical discussions to this Journal.

So the reason for the review is to acclaim a technician and professional military man who betimes uses his gift for writing and shares his enjoyment with the reader of fiction. In itself this is commendatory. We need more writing military men—if reviews of their works here will tend to encourage them ARMY ORDNANCE is all for it. The reviewer makes no bones about the fact that he enjoyed the stories and recommends them to young and old who like diversified reading. Captain Meek writes a bristling good story well. O. E. D.



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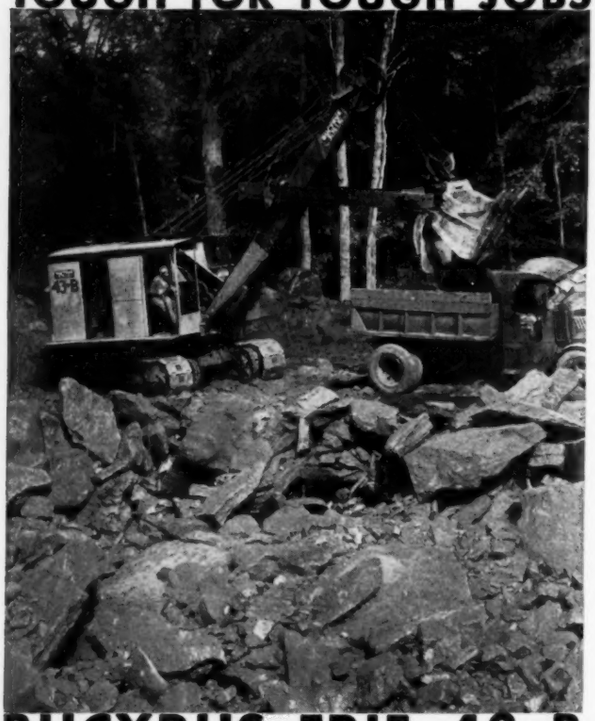

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